DECEMBER 1980 Volume 5, Number 12 $2.50 in USA/$2.95 in Canada

BYTE®

A McGRAW-HILL PUBLICATION

the small systems journal

ADVENTURE

Cromemco accepts your challenge, Data General

Yes, Data General, we saw your ad.

So we realize you hope to win over some of our computer business.

And we can see you have reason to be pleased about your line of minicomputers. They _are_ MINIs though.

But Cromemco produces state-of-the-art MICROcomputers.

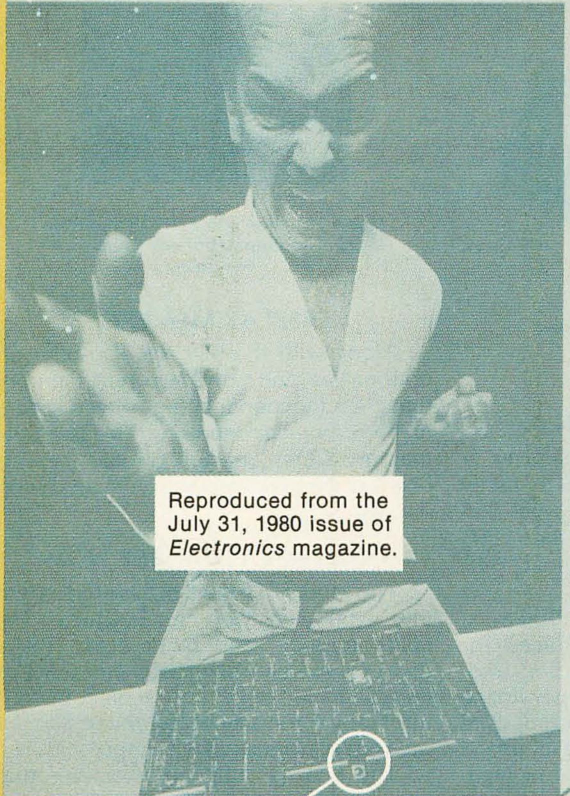
Powerful ones.

And our micros have some outstanding advantages.

For example, _Cromemco is the only microcomputer manufacturer to support a broad range of microcomputers with (a) 5-inch double-sided, double-density floppy disk drives and with (b) 8-inch double-sided, double-density floppy disk drives AS WELL AS (c) 8-inch Winchester hard disk drives._

That means, of course, that our customers have a wide choice of disk storage capability.





Reproduced from the July 31, 1980 issue of *Electronics* magazine.

Announcing MBC/2 and MBC/3, the newest members of Data General's growing family of microNOVA™ board computers. They're the best computers on a board money can buy. You get up to 64K bytes of memory, serial and parallel I/O lines, and software support from MP/OS, our famous micro operating system. You even get supporting languages like MP/PASCAL and MP/FORTRAN IV. See for yourself.

	microNOVA MBC/1	MBC/2	MBC/3	LSI/ 11/2	SBC/ 86/12
RAM Bytes	2K	8K	32K	8K	32K
PROM EPROM Bytes	4K	32K	32K	–	16K
Serial Lines	1	2 ASNYC/ SYNC	2 ASNYC/ SYNC	–	1
Dig I/O Lines	32	32	32	–	24
# Boards	1	1	1	2	1
Board Size	7.5x9.5	7.5x9.5	7.5x9.5	8.5x5.2	6.75x12

The competition will always sing the praises of their little single board computers. But from now on they'll be doing it falsetto.

Data General Corporation, Westboro, MA 01580, (617) 366-8911. microNOVA is a trademark of Data General. ©Data General Corporation, 1980.

Data General

Mail to: Data General Corporation, Westboro, MA 01580.
☐ I don't need busted boards. Send complete information on the MBC product line. ☐ I hurt. Send a salesman ASAP.
Tel.

UNEQUALLED SOFTWARE SUPPORT

OK. That was one point.

Here's another: our stunning selection of software support. _Cromemco is the only micro manufacturer to produce both single-user and multi-user multi-tasking computers with software like this:_

SYSTEM SOFTWARE

- CDOS (a CP/M-like operating system)
- CROMIX (a UNIX-like operating system)
- RPG-II (IBM-compatible)
- COBOL
- BASIC
- FORTRAN IV
- RATFOR
- LISP
- C
- Macro Assembler

APPLICATION SOFTWARE

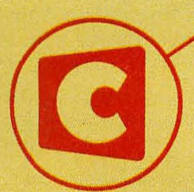
- Word Processing System
- Data-Base Management
- General Ledger
- Accounts Receivable
- Accounts Payable
- Inventory

All of this is available now with more coming all the time.

So there you are, D.G.

You can see why we know our microcomputers will stand the test.

Cromemco eagerly accepts the challenge.



Cromemco logo on computer board shown in original ad

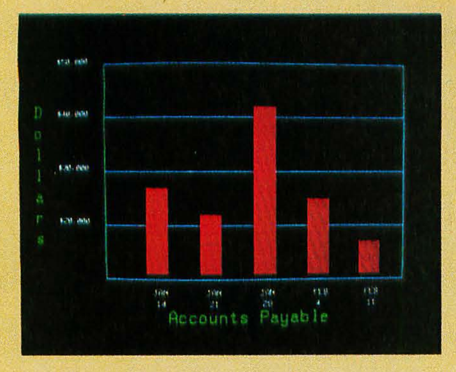


Cromemco™ incorporated

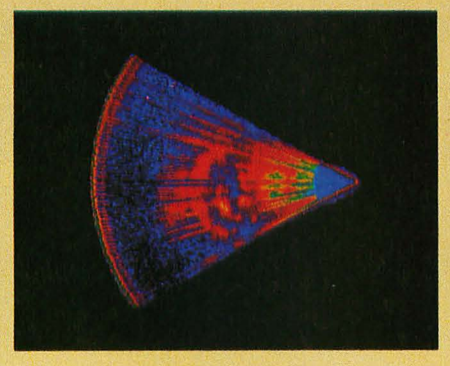
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Circle 1 on inquiry card.



Management Information Display


Ultrasonic heart sector scan


High-resolution display with alphanumerics

Get the professional color display that has BASIC/FORTRAN simplicity

LOW-PRICED, TOO

Here's a color display that has everything: professional-level resolution, enormous color range, easy software, NTSC conformance, and low price.

Basically, this new Cromemco Model SDI* is a two-board interface that plugs into any Cromemco computer.

The SDI then maps computer display memory content onto a convenient color monitor to give high-quality, high-resolution displays (756 H x 482 V pixels).

When we say the SDI results in a high-quality professional display, we mean **you can't get higher resolution than this system offers in an** NTSC-conforming display.

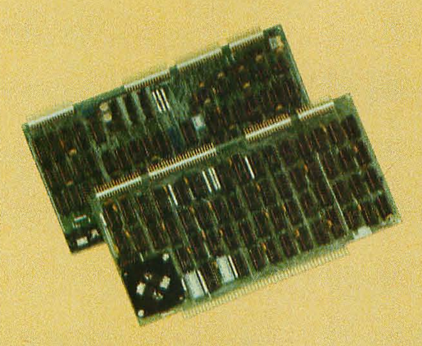
The resolution surpasses that of a color TV picture.

BASIC/FORTRAN programming

Besides its high resolution and low price, the new SDI lets you control with optional Cromemco software packages that use simple BASIC- and FORTRAN-like commands.

Pick any of 16 colors (from a 4096-color palette) with instructions like DEFCLR (c, R, G, B). Or obtain a circle of specified size, location, and color with XCIRC (x, y, r, c).

*U.S. Pat. No. 4121283


Model SDI High-Resolution Color Graphics Interface

HIGH RESOLUTION

The SDI's high resolution gives a professional-quality display that strictly meets NTSC requirements. You get 756 pixels on every visible line of the NTSC standard display of 482 image lines. Vertical line spacing is 1 pixel.

To achieve the high-quality display, a separate output signal is produced for each of the three component colors (red, green, blue). This yields a sharper image than is possible using an NTSC-composite video signal and color TV set. Full image quality is readily realized with our high-quality RGB Monitor or any conventional red/green/blue monitor common in TV work.



Model SDI plugs into Z-2H 11-megabyte hard disk computer or any Cromemco computer

DISPLAY MEMORY

Along with the SDI we also offer an optional fast and novel **two-port** memory that gives independent high-speed access to the computer memory. The two-port memory stores one full display, permitting fast computer operation even during display.

CONTACT YOUR REP NOW

The Model SDI has been used in scientific work, engineering, business, TV, color graphics, and other areas. It's a good example of how Cromemco keeps computers in the field up to date, since it turns any Cromemco computer into an up-to-date color display computer.

The SDI has still more features that you should be informed about. So contact your Cromemco representative now and see all that the SDI will do for you.

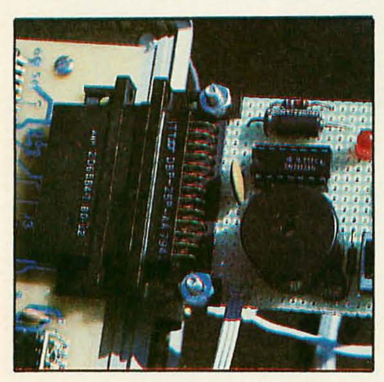


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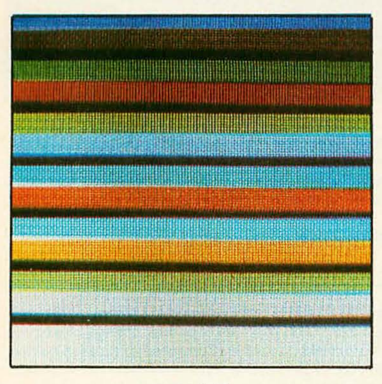
In The Queue

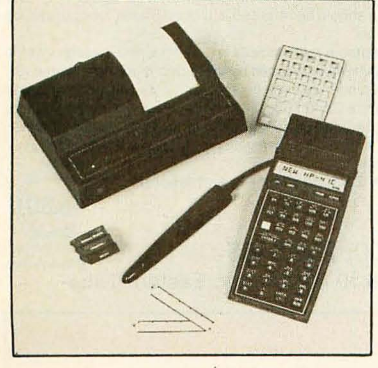
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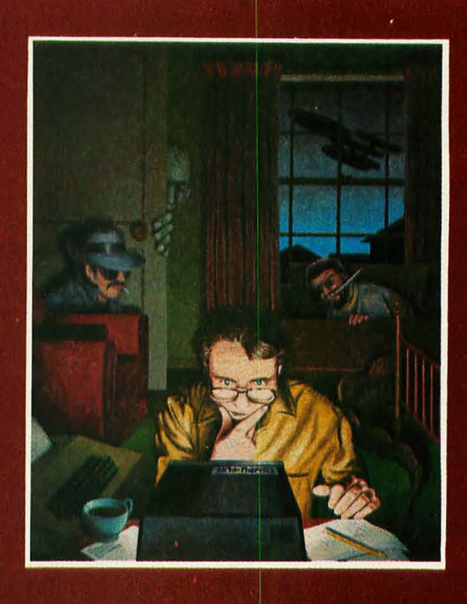

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Foreground

Background

Product Reviews: Games

Nucleus



In This Issue

Although the mysteries and menaces lurking in the shadows of this issue's cover may exist only in the minds of an imaginative Adventure player or the cover artist, Robert Tinney, that doesn't make them any less real to the person playing the game. This issue explores the many aspects of Adventure and Adventure-like games. It includes two complete Adventures in BASIC, an excellent introductory article ("On the Road to Adventure," by Bob Liddil), two articles on the state of the art in Adventure games, and a handful of game reviews.

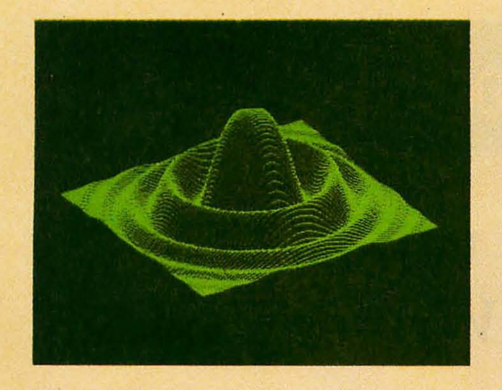
This issue also contains "Computer Testing," an article by Steve Ciarcia, as well as the second parts of several articles continued from the November graphics issue: "Micrograph," "Graphic Color Slides," and "A Simplified Theory of Video Graphics."

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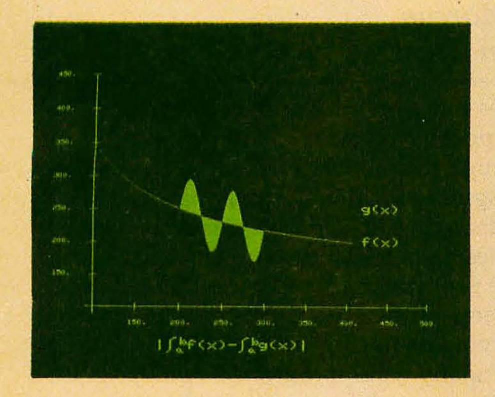


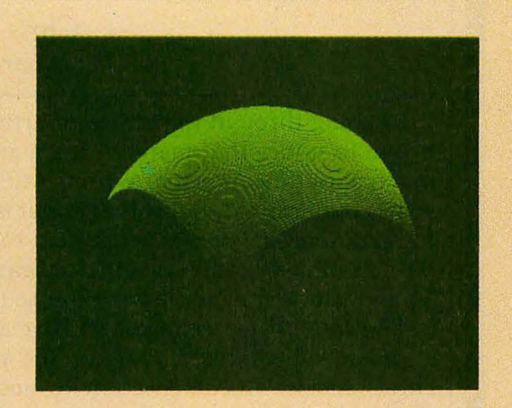
MICROANGELO

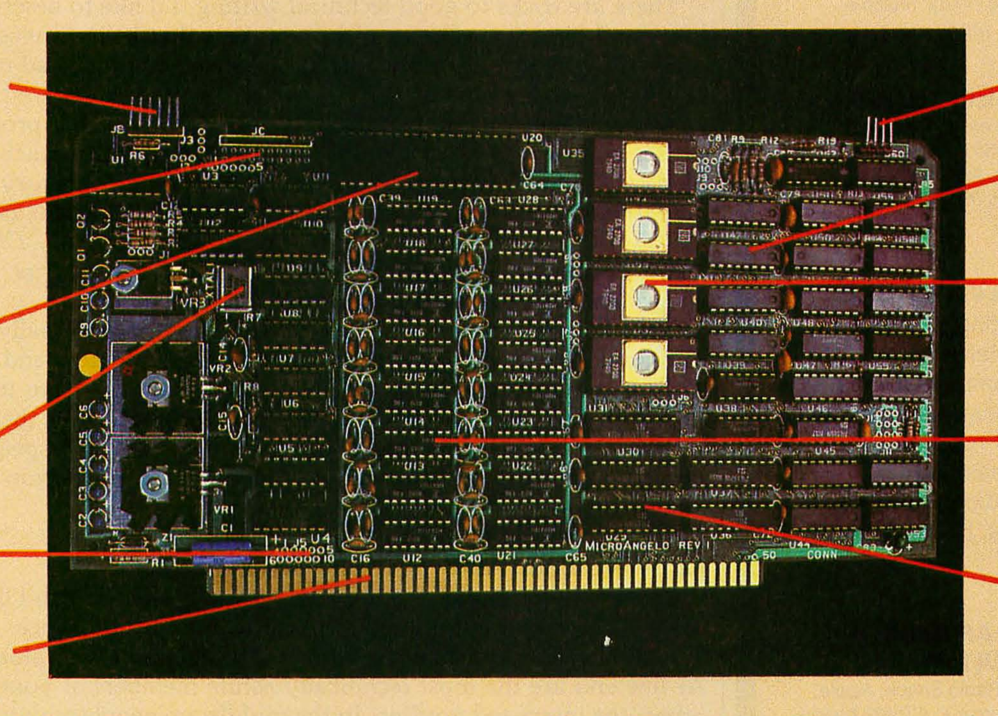
HIGH RESOLUTION GRAPHICS SINGLE BOARD COMPUTER

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Screenware™ Pak I

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An interface software package that coordinates input/output from the MicroAngelo™ graphics board, the MicroAngelo™ keyboard, and your computer. The result is a flexible, yet sophisticated graphics terminal.

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Editorial

What's Wrong with Technical Writing Today?

Chris Morgan
Editor-in-Chief

In going through the scores of articles that cross my desk each month, I've begun to notice that many of them are poorly written. I'm talking here not so much about incompetent writing (although the number of spelling and syntax errors is alarming), but rather about *misguided* writing, writing that is difficult to read, unclear, or wasteful of the reader's time. The problem is certainly not BYTE's alone. Editors of other magazines have told me much the same story. Thinking about possible solutions to the problem led me to write this editorial.

The quality of technical writing affects all of our readers in one way or another. Whether you program for a living or just for fun, you need to write clear, concise documentation to accompany your programs. And you undoubtedly have to write reports as part of your job or your studies.

There *are* tricks to good technical writing. I'd like to describe some of them here, and list some sources of information that have proved helpful to us in our writing work. I've also included a list of recommended reading at the end of the editorial.

Ask someone on the periphery of our field what the problem is with our prose, and he or she will probably say, "There's too much jargon." Things like: *I/O, ASCII, byte, CPU, compiler, nonvolatile memory, BASIC, NAND gate, modem, macro, Pascal, floppy disk, Z80, 8080, 8086, 6809, 6502, 68000, Z8000, BCD, CP/M, Unix, Xenix, bootstrap, OS, DOS, DMA, CAI, CAD, CAM, vectored interrupt, monitor, RS-232C, S-100 bus, global variable, checksum, NOP, SWI, VOM,* and so on, and so on.

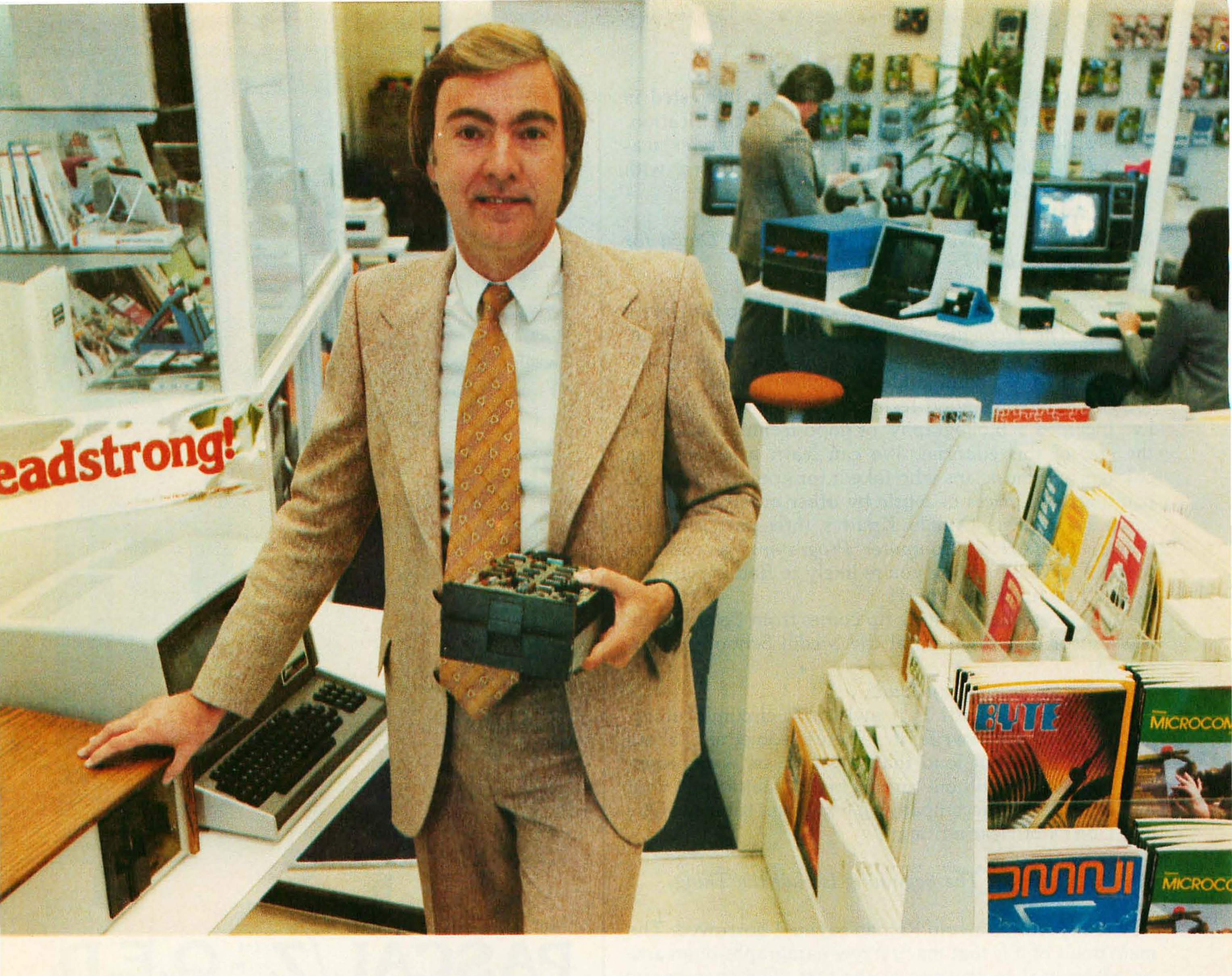
It's a lexical maze for the uninitiated. But is jargon really our downfall? I think not. We need jargon in the same way that doctors and psychologists do — as a convenient form of shorthand. Programmers have traditionally wrestled with the problem of fitting the most program into the least amount of memory space, so it's only natural that their everyday speech has been condensed down to a sort of technical "alphabet soup." Jargon isn't intrinsically bad — it's how you use it that counts.

Knowing Your Audience: The Seesaw Effect

Outside of grammar, syntax, and spelling (all of which I'll deal with later), there is the major consideration of your intended audience.

Imagine your readers to be sitting at irregular intervals along a large seesaw. At one end are the most technically astute members of your audience; at the other, the interested novices. In the middle are people with varying degrees of knowledge in the subject you are writing about. Your job is to keep the seesaw as level as possible by attending to the various groups in proportion. If there are many novices involved, you must "hold up" their side by providing them with a lot of introductory material. But if you go too far in this direction, the experts will get bored, dismount, and leave you hanging with a partial audience. It's a quandary, one that has no simple answer. Some topics are so technical that even the most intelligent novice will be left in your wake. You can't understand the workings of a compiler, for instance, until you know a lot about computer languages in general.

Some seesaws can't be balanced despite the best intentions of the writer. It is the job of the writer to know this. Nevertheless, within limits, a lot can be



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"I sell systems my customers can depend on. That's why most of the personal and small business computer systems sold here feature Minifloppy disk drives. I know from experience I can rely on the Minifloppy."

Since 1976 Shugart's Minifloppy has been used by more small computer system manufacturers than any other drive. In fact, more than half-a-million Minifloppys have been installed. The Minifloppy looks small—but it stores a lot of data. 250 kilobytes on one side, or up to 500 kilobytes in the double-sided model. That's about 50 pages of printed information on a single-sided Minidiskette, and twice that on the double-sided version. You'll have plenty of storage capacity for your programs, letters, forms, or ledger entries. And you find your data fast, too, because the Minifloppy is a random access device that eliminates the need to search for your data serially as you must with a tape cassette unit.

No matter what problem you're solving with your computer system, you can rely on Shugart's Minifloppy for data storage. We're known as the Headstrong company for good reason. We're Headstrong about reliability, quality, and value. Ask your dealer. He knows us.

Rely on the Headstrong Company.

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done to encourage those readers who are interested in your topic, but who may need some extra clarification. This leads me to the first of what I immodestly refer to as *Morgan's Laws of Writing* (not to be confused with DeMorgan's Law):

Morgan's Law #1: *No Writer Ever Got Shot Down for Writing Too Clearly.*

How do you write clearly? A good first step is to buy a copy of *The Elements of Style* by Strunk and White. There is more wisdom contained in this slim volume than in many a three-pound guide to English Usage.

Next, find some good technical writing and study it. I've included a bibliography of good technical books at the end of this editorial. We can learn a lesson from painters and musicians who take it for granted that good paintings and pieces of music by other artists should be carefully studied. Donald Knuth's three-part series of books, *The Art of Computer Programming*, contains some of the best writing you're likely to find in our field — and he's funny, to boot!

Another excellent writing tip comes from Peter Jacobi, a professor of journalism at the Medill School of Journalism:

Read your writing out loud.

How does it sound? Is it awkward, circumlocutory, pedantic? If so, rewrite it. There's something about reading a piece out loud that lays bare its weaknesses. You can be clear without turning off the majority of your audience. See the accompanying text boxes for some Do's and Don't's of clear writing.

Morgan's Law #2: *The Beginning Is Half the Thing.*

Actually, this is an old Roman saying I borrowed. The main point of it is that the first few paragraphs of an article are crucial to the rest of the text. The chances are you'll win or lose your readers at the beginning. Still, it's the one part of an article that fledgling writers gloss over in their eagerness to write the main body of the text. One very good writer I know told me he spends up to *half* of his article-writing time creating the first few paragraphs!

Morgan's Law #3: *Avoid the Penguin Syndrome.*

A famous story made the rounds a few years ago involving a publisher of children's books. A copy of one of the company's books about penguins appeared in the publisher's mailbox along with a letter from an eight-year-old girl that read, "Dear Sirs: I am returning your book, because it told me more about penguins than I wanted to know."

The moral? Tell your readers what they need to know, and no more. If you're zealous about a given topic, tell the reader how to get more information by including a comprehensive list of references. Don't waste space.

Morgan's Law # 4: *Writing Is Nonlinear.*

Article ideas don't come in an orderly sequence. Be prepared to jot down your ideas as they come, as writer John McPhee does. McPhee is blessed with a short-term memory that permits near-total recall. Even so, he writes

Circle 4 on inquiry card.

Outside of the garden you need a computer that can grow.

For the average garden-variety home and hobby operation, a high quality personal computer is a real temptation. But let's face it: in the world of business, engineering and scientific applications you need a system that can keep up with bigger ideas.

Bigger ideas today mean the power and flexibility to move the micro up to and beyond the level of yesterday's minis. More memory to hold bigger data bases. More flexibility to handle a variety of data entry devices. More programming and computing power for numbercrunching and applications development. And easy upgrade to 16 bit operation when you need it.

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Intersystems Series II is the most complete line of fully IEEE 696 compatible S-100 boards...easily upgradeable to our MPU 8000™ or other 16 bit S-100 CPU's as they become available...so you're never locked out of rapid expansion, or locked into obsolescence, by dependency on a proprietary product line.

So if you've left those garden-variety applications behind, come to Intersystems and get a system that will grow as big as your next idea. Get it from the people who know small computers...your Computerland store...or other fine full service computer dealers.

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Micros for bigger ideas.

his ideas on index cards every day and pins them to a bulletin board where he can mix and match them. The actual writing of a piece might not occur until some time later. E B White recommends that writers use scissors and glue to cut and paste their efforts during the first-draft stage. Some of the more advanced word-processing programs can help to do this. Another great writing aid is to use a data-base-handling program that allows you to cross-index ideas and file them away.

Morgan's Law #5: *(otherwise known as the Three-Foot Rule): Don't Write Anything Unless You Have a Dictionary and a Thesaurus Within Three Feet of You.*

I know I'm being a little strict here, but it's important. Unless the dictionary is within easy reach, you probably won't bother to use it, and you may make a spelling error. Going without a thesaurus is a further way of handicapping yourself. Both these books are vital to every writer, and I needn't tell you that the average level of spelling accuracy these days is low. *The American Heritage Dictionary* is a good all-round choice because of its excellent usage notes.

There's nothing much I can say about improving grammar and syntax other than to suggest the reference books at the end of the editorial. *The Careful Writer* and *Mrs. Thistlebottom's Hobgoblins* by Theodore Bernstein both help to dispel many of the bugaboos that have haunted our language ever since the well-meaning Victorians got their hands on it. Bernstein correctly points out that it's all right to occasionally split an infinitive, or to use a preposition to end a sentence with. William Sloane's *The Craft of Writing,* although primarily aimed at the fiction writer, contains a valuable chapter on nonfiction. It's a beautifully written book.

Morgan's Law #6: *Don't Be Afraid to Be Interesting.*

This may be the most important law of all. Involve your reader by being specific. Generalities make for dull reading. Use humor if you can carry if off. Otherwise, don't! Add some personal observations and opinions. The reader will take them in stride.

All of this leads to the general conclusion that you should write about what you know well. William Sloane says, "There are no uninteresting subjects, only uninteresting writers."

In closing, I can think of no better quote than the following one from the same book (although Sloane is talking here about nonfiction books, the sentiment applies equally well to technical articles):

> *If a book has a beginning, it also has an end. Nonfiction develops by increment, builds on its own material, and ends when its material has been completely exploited. If the book fulfills its contract with the reader, the end will complete the book by fulfilling the promises it made at the start. And if the people who read that book feel continuously that they are added to and believe, at the end, that there is more to them than there was before, the work of nonfiction has succeeded. The same can be said of fiction. In both cases, the contract between the writer and the reader has been kept.*

Clear Writing: Some Do's

DO: *(1) Tell your audience what you're going to talk about, (2) Talk about it, and (3) Tell them what you talked about. This old saw from your creative-writing class in high school is as valid as ever. Not observing it is a common failing of much technical writing today.*

DO: *Include a* theme sentence *near the beginning of your writing that concisely sums up what you want to say in the piece.*

DO: *Tell your story in miniature in the captions to figures, photos, tables, listings, and other illustrations. Your readers may not have time to read all of your article: give them a quick summary and they'll thank you for it.* Scientific American *magazine does this sort of thing very well.*

DO: *Spell out acronyms and abbreviations when they first appear in text. How many times have you been stopped cold by an unfamiliar abbreviation in the middle of an interesting article?*

DO: *Use verbs. Avoid adjectives and adverbs. A verb in an article title can add a lot of spice. (See* Electronics *magazine for good examples of verbs in titles.) Adjectives and adverbs, to paraphrase Robert Benchley, are the spinach of technical prose. Everybody says they're vital, but few of us would miss them if the majority of them suddenly disappeared tomorrow. John McPhee (perhaps the best nonfiction writer in the country) has written several books on technical subjects (such as* The Curve of Binding Energy) *that illustrate these principles better than a hundred paragraphs from me.*

DO: *Break up your text into digestible chunks with subheadings.*

DO: *Remember the questions* you *had when you were first learning a subject.*

Clear Writing: Some Don'ts

DON'T: *Use the passive voice as your primary voice. Many of us were taught to use the passive voice when writing technical reports and the like. But the passive voice lends an air of coldness and formality to writing — the sort of thing you'd expect in technical transactions, but not in an article that's designed to be* read. *For example, "I ran the program" is more personal than "The program was run." Sometimes you need the passive voice for variety, but in general, own up: Say* I, me, my, we, us *or* you.

DON'T: *Make your reader search for information in an article. If you have a list of items in text, perhaps they could be set off in a table. If you have a glossary in your article, tell the reader at the beginning.*

DON'T: *Use big words when small words will do. A good example is* utilize, *a word that can almost always be replaced with* use. *Another popular word that should be avoided is* implement. *Don't implement when you can* install, design, code, control, enable, connect, build, *or* operate; *your readers will have a better idea of what you are doing.*

DON'T: *Use a clever title for an article if it fails to convey the article's content. Imagine that your title is all that the reader has to go on in deciding whether or not to read your work.*

Text box continued on page 12

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Why not kill two birds with one stone?

If you have an Apple* and you want to interface it with parallel and serial devices, we have a board for you that will do both. It's the AIO.™

Serial Interface.

The RS-232 standard assures maximum compatibility with a variety of serial devices. For example, with the AIO you can connect your Apple* to a video terminal to get 80 characters per line instead of 40, a modem to use time-sharing services, or a printer for hard copy. The serial interface is software programmable, features three handshaking lines, and includes a rotary switch to select from 7 standard baud rates. On-board firmware provides a powerful driver routine so you won't need to write any software to utilize the interface.



Parallel Interface.

This interface can be used to connect your Apple* to a variety of parallel printers. The programmable I/O ports have enough lines to handle two printers simultaneously with handshaking control. The users manual includes a software listing for controlling parallel printers or, if you prefer, a parallel driver routine is available in firmware as an option. And printing is only one application for this general purpose parallel interface.

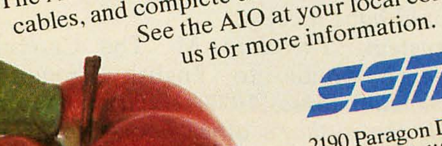


Two boards in one.

The AIO is the only board on the market that can interface the Apple to both serial and parallel devices. It can even do both at the same time. That's the kind of innovative design and solid value that's been going into SSM products since the beginning of personal computing.

The AIO comes complete with serial PROM's, serial and parallel cables, and complete documentation including software listings.

See the AIO at your local computer store or contact us for more information.



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San Jose, California 95131
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Maybe we can save you a call.

Many people have called with the same questions about the AIO. We'll answer those and a few more here.

Q: Does the AIO have hardware handshaking?
A: Yes. The serial port accommodates 3 types—RTS, CTS, and DCD. The parallel port handles ACK, $\overline{ACK}$, BSY, STB, and $\overline{STB}$.

Q: What equipment can be used with the AIO?
A: A partial list of devices that have actually been tested with the AIO includes: IDS 440 Paper Tiger, Centronics 779, Qume Sprint 5, NEC Spinwriter, Comprint, Heathkit H14, IDS 125, IDS 225, Hazeltine 1500, Lear Siegler ADM-3, DTC 300, AJ 841.

Q: Does the AIO work with Pascal?
A: Yes. The current AIO serial firmware works great with Pascal. If you want to run the parallel port, or both the serial and parallel ports with Pascal, order our "Pascal Patcher Disk."

Q: What kind of firmware option is available for the parallel interface?
A: Two PROM's that the user installs on the AIO card in place of the Serial Firmware PROM's provide: Variable margins, Variable page length, Variable indentations, and Auto-line-feed on carriage return.

Q: How do I interface my new printer to my Apple using my AIO card?
A: Interconnection diagrams for many popular printers and other devices are contained in the AIO Manual. If your printer is not mentioned, please contact SSM's Technical Support Dept. and they will help you with the proper connections.

Q: I want to use my Apple as a dumb terminal with a modem on a timesharing service like The Source. Can I do that with the AIO?
A: Yes. A "Dumb Terminal Routine" is listed in the AIO Manual. It provides for full and half duplex, and also checks for presence of a carrier.

Q: What length cables are provided?
A: For the serial port, a 12 inch ribbon cable with a DB-25 socket on the user end is supplied. For the parallel port, a 72 inch ribbon cable with an unterminated user end is provided. Other cables are available on special volume orders.

The AIO is just one of several boards for the Apple that SSM will be introducing over the next year. We are also receptive to developing products to meet special OEM requirements. So please contact us if you have a need and there is nothing available to meet it.



SSM Microcomputer Products
2190 Paragon Drive
San Jose, California 95131
(408) 946-7400

DON'T: *Use* it *or other pronouns if the meaning is obscured. Vague pronoun references in an article slow the reader down. What does the* it *mean?*

Writing for BYTE

If you'd like to write for BYTE, we offer the following guidelines:

Knowing the reader: *Over three-quarters of BYTE's readers are involved professionally with computers as programmers, systems analysts, engineers, or technicians. Most of them are dyed-in-the-wool hobbyists at heart and spend a lot of time with their systems. The majority have college degrees or higher, although we also have many student readers. They are interested in virtually every aspect of personal computing, including high-level languages, original hardware designs, reviews of software and hardware (we are especially interested in these), graphics, artificial intelligence, using computers to control the home, games, robots, etc, etc.*

Although many of our articles contain highly technical information, we also encourage the submission of lower-level tutorial articles to enable readers to brush up on the basics. BYTE's readers like to have fun with their systems, too — a fact that should not be overlooked.

Form of the Submitted Article

- *All submissions should be double-spaced and typewritten on 8½ by 11 inch paper, with the narrow dimension vertical. Double-spacing is important, since proofreader's marks and other additions must be made to the manuscripts.*
- *Take the time to write complete, descriptive captions for all figures, tables, listings, and photos.*
- *Schematic diagrams should be neatly drawn, using the schematics in BYTE as a guide. Note that we prefer a certain type of connector designation, and that power connections to integrated circuits are usually listed in a separate power-wiring table rather than being included in the schematic. The direction of flow in a flowchart is assumed to be downward and to the right. No directional arrows should be used unless the flow is contrary to the aforementioned directions. Again, see the magazine for examples.*
- *We prefer not to typeset listings, but rather to photograph them for the magazine in order to eliminate the possibility of typographical errors. Because of this, we ask authors to submit listings printed on* white *paper with a dark ribbon (preferably new).*
- *Photographs can be either color or black and white, but should be as sharp as possible. We prefer color slides to color prints.*
- *All submissions should be accompanied by a stamped, self-addressed envelope with sufficient postage affixed. We acknowledge all manuscripts upon arrival, and make a final determination within 8 to 12 weeks.*

Reference Books

Rathbone, Robert R. Communicating Technical Information. *Reading MA: Addison-Wesley, 1972. A good source of information about technical writing.*

Ralston, A, and Meek, C, eds. Encyclopedia of Computer Science. *New York: Petrocelli/Charter, 1976. Although this book is oriented more toward large computers, it contains a wealth of information about high-level languages, assembly language, data processing, and hundreds of other topics, all presented in lucid fashion. Every serious computer science library should have a copy.*

Bernstein, Theodore M. The Careful Writer: A Modern Guide to English Usage. *New York: Atheneum Press, 1977. Highly recommended, along with the author's other book,* Mrs. Thistlebottom's Hobgoblins.

Burton, Philip E. A Dictionary of Microcomputing. *New York: Garland Publishing Company, 1976. Still the best dictionary in the microcomputing field.*

Turner, R P. Technical Writer's and Editor's Stylebook. *New York: Howard W Sams and Company, 1964.*

Todd, Alden. Finding Facts Fast. *Berkeley CA: Ten*

Editorial continued on page 294

Letters

Heath Faces Horizon

John Dye remarked in his letter (August 1980 BYTE, page 18) that he cannot run his Heathkit H-14 printer with a North Star Horizon at any data transfer rate over 110 bps (bits per second). A simple reconfiguration of the Horizon headers, as designed by Don Baker, will allow it to recognize the $\overline{\text{BUSY}}$ from the H-14.

I have assembled three H-14s and interfaced them with Horizon systems at 4800 bps with no problems. Heathkit supplies a modification-instruction pamphlet which allows you to obtain a $\overline{\text{BUSY}}$ signal on the printer's connector pin 4. This pin translates to pin 15, DB:XMIT CLK (DCE), on the Horizon motherboard. To accomplish the handshaking, jumper the right configuration-header at location 4D as follows:

Connect pin 2 to pin 16
Connect pin 4 to pin 14
Connect pin 5 to pin 11
Connect pin 7 to pin 8
Connect pin 9 to pin 10 and
Connect pin 12 to pin 12 of the right special-clock header at location 2C.

David M Koehler
306 Timber Trl
Lafayette IN 47905

The APL Plot

I was very pleased to see BYTE's August 1980 FORTH issue, since I am working part-time with FORTH doing a computer-aided design package to be used with the fine Mauro Engineering Proac plotter. Incidentally, the new product announcement for this plotter in the August 1980 BYTE (page 249) referred erroneously to the unit as a printer in the heading.

The self-replicating programs in "Programming Quickies" (see "Self-Reproducing Programs," by Burger, Brill, and Machi, August 1980 BYTE, page 72) are a challenge that APLers cannot pass up. I have a 22-character line of APL that reproduces itself when executed, which was published a few years ago in *APL News*, a free publication of APL Press (not to be confused with *Personal APL News*, my publication, which is now part of the *APL Market Newsletter* from Southwater Corporation). Anyone who is interested should contact Eugene McDonnell of I P Sharp in Palo Alto, California.

If we take the character string:

```
A←'1↓23ρ11ρ''''''1↓23ρ11ρ'''''''
```

and then print it and execute it, we get:

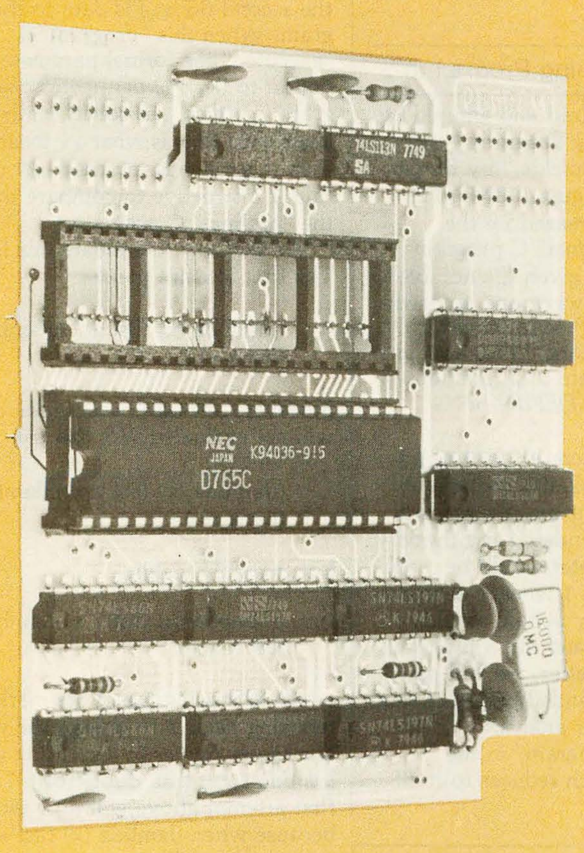
```
      A
1↓23ρ11ρ'''1↓23ρ11ρ'''
      ⍎A
1↓23ρ11ρ'''1↓23ρ11ρ'''
```

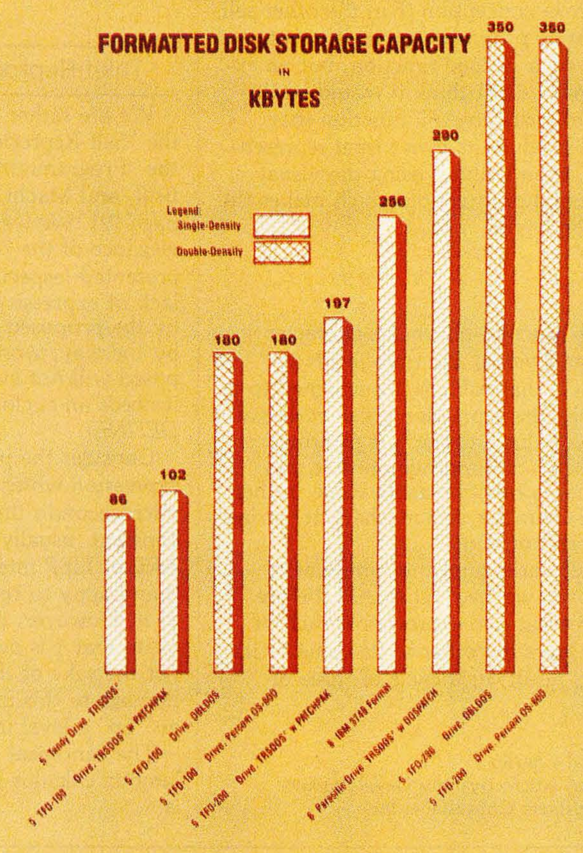
The key to this line is the fact that the reshape function wraps around to the beginning of the right argument. I hope that the following makes it clear what is happening:

```
          '''1↓23ρ11ρ'''
'1↓23ρ11ρ'
         11ρ'''1↓23ρ11ρ'''
'1↓23ρ11ρ''
```

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```
        23ρ11ρ'''1↓23ρ11ρ'''
   '1↓23ρ11ρ'''1↓23ρ11ρ'''
```

This is much shorter and also much simpler in conception than the other self-replicating programs given. It is not, however, a defined function, but an expression. I don't think it would be difficult to write an APL function that would produce its own visual representation, even without using the visual representation function which makes the question trivial:

```
        ∇R←MYSELF
   [1]    R←⎕VR 'MYSELF'
        ∇
```

This function returns its character form as a value, and only prints by default if that value is not assigned to a variable; the expression given earlier also yields a value and not just printing. Only LISP can improve on that, by returning a function as its value, rather than a character vector (character string to the rest of you).

Other variants of this amusement have been worked out in APL before. Try creating two expressions, each of which gives the other as its value or its printed result, or a cycle of three or more.

Mokurai Cherlin
Director, Micro Systems Development
APL Business Consultants Inc
APL Computer Language Specialists
POB 1131
Mt Shasta CA 96067

Thlef-Reproduthing Programth

We are rather amazed and amused by the "Self-Reproducing Programs" (see the "Programming Quickie," by Burger, Brill, and Machi, August 1980 BYTE, page 72). We were amazed by the elegance of the "optimal" C program presented (especially given C's notable lack of expressive power), and amused by the proposed LISP solution (which, by the way, won't work. What was proposed will not evaluate to a function — it needs an enclosing *DEFUN* or *DEFINE*).

Consider the problem of creating an expression which evaluates to itself. A microsecond's thought usually yields a constant, usually 1. Indeed, any friendly APL or LISP interpreter would be more than happy to return 1 when 1 is typed to it. However, many people would claim that 1 is data, and not a program. For the sake of this letter, we will pay homage to this unfounded prejudice, and go "up" a level in our analysis.

The canonical "program" in the lambda calculus which reduces to itself is:

$$(\lambda\chi.\chi\chi)(\lambda\chi.\chi\chi).$$

The first $(\lambda\chi.\chi\chi)$ is the "program" and the second $(\lambda\chi.\chi\chi)$ is data to the program. When this "program" is "executed" the formal parameter χ is bound to $(\lambda\chi.\chi\chi)$ parameter of the program (χ), then χ is concatenated with itself once (this is what $\chi\chi$ means), and then this value is returned. (You may find it instructive to compare this with the "optimal" C program.)

We shall try to emulate this in LISP. The first attempt yields:

```
((lambda (x) (list x x))(lambda (x)
(list x x))),
```

however, this fails because the data part will get evaluated. We can try:

```
((lambda (x) (list x x))'(lambda (x)
(list x x)))
```

but this only yields:

```
((lambda (x) (list x x))(lambda (x)
(list x x))),
```

which is missing the quote mark. An interesting hack is to change the way *lambda* evaluates by executing (macro lambda form (list 'quote form)). The first attempt above will now work because when (lambda (x) (list x x)) is evaluated it will return a copy of itself, which is what we want. However, there are those that would claim this is cheating because we have implicitly changed the behavior of the evaluator. We will admit this objection and continue with our analysis.

After much mushing around trying to get the quote mark back in we stumble upon:

```
((LAMBDA (LAMBDA)(LIST(LIST
'LAMBDA '(LAMBDA)
LAMBDA)(LIST 'QUOTE
LAMBDA)))
'(LIST (LIST 'LAMBDA
'(LAMBDA)
LAMBDA)(LIST'QUOTE
LAMBDA)))
```

which does what we want. Note that this uses no *PROG*, *SETQ*'s or *REPLAC*χ's. Also note that the lambda variable need not be named *lambda*, this is merely a hack. It is trivial to make a program out of this expression by throwing up the necessary *DEFUN*'s:

```
(DEFUN PRINTME()
((LAMBDA (LAMBDA)(LIST
'DEFUN
'PRINTME'()(LIST(LIST'LAMBDA
'(LAMBDA) LAMBDA) (LIST
'QUOTE LAMBDA))))
'(LIST 'DEFUN
'PRINTME'()(LIST(LIST 'LAMBDA
```



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```
'(LAMBDA) LAMBDA) (LIST
'QUOTE LAMBDA)))))
```

However, neither of these two solutions would be written that way in a modern LISP (eg: MacLISP or Lisp-MachineLISP, instead using the *backquote facility* they would be written:

```
((lambda (x) '(,x ',x)) '(lambda (x)
'(,x',x)))
```

and:

```
(DEFUN PRINTME()
((LAMBDA (X) '(,@X',X)))
'(DEFUN PRINTME ()((LAMBDA
(X) '(,@X',X)))))
```

The real way it would be written in MacLISP is (DEFUN PRINTME () (GRINDEF PRINTME)). This whole exercise really isn't very interesting in LISP because this sort of thing is done routinely. Routines are constantly being *cons*ed up by other routines, and macros which write their own macros are becoming a standard tool. LISP doesn't discriminate against something just because it is code.

Daniel Weise
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Cambridge MA 02139

Leedex / Sup'R' Terminal Incompatibility

Any BYTE reader who owns an Apple II system and is considering expanding to 80 columns may be interested in my experience with the Leedex monitor and the Sup'R' Terminal RF (radio-frequency) modulator board. While the Leedex monitor is an excellent value and performs well with the standard 40-column Apple II, I found it impossible to get a clear display while using it in conjunction with the Sup'R' Terminal board. Repeated efforts at adjusting both the board and the monitor failed to produce a legible display. The only solution proved to be using another monitor, namely a Hitachi.

Sunil Subbakrishna
Shakti Systems
Wilmette IL 60091

Bar-Code Reader as Light Pen?

Before reading Carl Helmers's editorial "Bar Codes, Revisited . . . " (April 1980 BYTE, page 6) on the Hewlett-Packard HEDS-3000 bar-code data-entry wand, I considered the possibility of buying a light pen for my Apple II. Afterwards, I couldn't see buying two pieces of equipment when one might do both jobs.

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Sophistication previously available only on experimental mini and mainframe computer synthesizers. Digital instrumental music synthesizer system. 16 voices in stereo. Instrument definitions simulate the sound of real instruments—and more. Fully programmable waveforms. Envelope Control. Composition system—sheet music input using standard music notation. Chords and multi-part scoring up to 16 voices. A true instrument that anyone with an Apple can play.

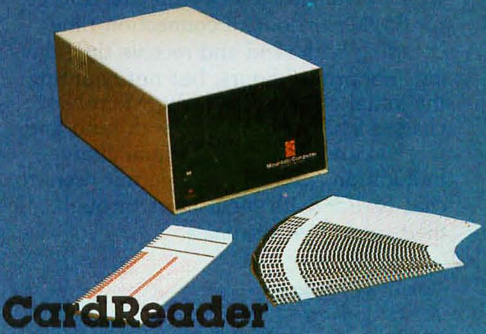
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*Based on Manufacturer's published catalogs—Apr. 1980

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That is, can the wand be altered so as to become a light pen?

John Gibbs

If you don't activate the infrared LED (light-emitting diode) in the HEDS-3000, you can certainly sense light coming into the wand from an external source, such as the video display's CRT (cathode-ray tube). There might be problems in matching the wave length of the light from the CRT to the spectral sensitivity of the infrared phototransistor in the wand . . . **CH**

Telecommunication Options

I enjoyed Carl Helmers's June editorial very much. (See "The Grass Roots Electronic Post Office, or, How Electronic (and Private) Mail Is Already Here," June 1980 BYTE, pages 6 thru 10.) The prospect of using my terminal for rapid and inexpensive communication is very exciting.

The costs you mention for sending computer messages using voice telephone lines can be greatly reduced by taking advantage of the digital communication provided by Telenet or Tymnet. This is easily done by means of The Source or MicroNet information services. Electronic mail can be sent with The Source for $8.50 per hour of connection time counting both send and receive time during "nonprime" hours, but not counting the initial charge. Similarly, MicroNet charges $10 per hour (for both send and receive) and has a lower initial charge. In addition, both systems permit users to chat on-line with other users through their respective terminals.

Robert W Hosken
Avatar Exports
21515 Hawthorne Blvd #432
Torrence CA 90503

According to my table of telephone rates, the cost for a one-hour telephone call from New Hampshire to California during the 60% discount time period (which Carl Helmers used as an example) would be $9.65. The cost would be less, of course, for a call over a shorter distance.

Using The Source or MicroNet has the benefit that the two correspondents do not have to send and receive simultaneously and opens the possibility for multiple recipients of the same communication . . . **RSS**

Info on Micropolis Software Wanted

The Micropolis Users Group (MUG) is an association whose desire is maximizing the use of the Micropolis-supplied software. As part of this endeavor, we are compiling a directory of all software that runs on MDOS or Micropolis BASIC without requiring a second operating system (such as CP/M). I would appreciate suppliers of such software informing me of their products.

Of course we are also always interested in new members. Membership is $12 per year for twelve monthly newsletters.

Buzz Rudow
Micropolis Users Group
604 Springwood Cr
Huntsville AL 35803

6809 Time-Sharing

Don Kinzer's article in the June 1980 BYTE ("A Time-Sharing/Multi-User Subsystem for Microprocessors," page 122) describes how a sixteen-user time-sharing system can be implemented. The system, based on a 6800 microprocessor, uses a minimum of hardware and software. However, using the new 6809 processor, even less hardware and software is required.

The first savings of hardware occurs at power-up/reset. Most processors, including the 6800, accept a nonmaskable interrupt (NMI) at any time—even at reset. Obviously, if an NMI occurs before the stack is initialized correctly, the program will bomb. The problem is usually solved by adding a special circuit that disables all interrupts until the processor is properly initialized (as shown in figure 4 of Kinzer's article).

On the 6809, the NMI is blocked until the first load of the system stack pointer (SP). Thus, no special reset circuitry is needed. After initialization is complete, the stack pointer is loaded to enable the NMI. Note that most interrupt timers must still be initialized; when using the 6809, simply use the RESET signal to clear the timer to a known state.

The 6809 allows direct addressing anywhere in the memory map. By use of a direct page (DP) register, the 64 K-byte addressing range is divided into 256 pages. In a time-sharing environment, the DP register could be loaded with a different value for each user, resulting in each user accessing a different 256 bytes of temporary storage.

An alternate method of implementing a time-sharing/multi-user system is with the 6829 memory-management unit (MMU). The MMU expands the address space of the 6809 from 64 K bytes to 2 megabytes. Each MMU can handle four concurrent tasks; the address space of each task can be fully protected from other tasks. In addition, a total of eight MMUs can be used in a system,

Letters continued on page 298

Your vehicle for com
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The general purpose microcomputer was first introduced as a computer for hobbyists and experimenters. However, as the industry has grown, microcomputers have become specialized for personal use or for small business use. There is virtually no computer for the serious experimenter with one important exception, the Ohio Scientific Challenger 8P.

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The C8P DF's specs beat all personal computers hands down. It executes instructions two to three times faster, and displays more alphabetic characters on its screen than other models. It has upper and lower case and graphics in 16 colors. The C8P's *standard* I/O capabilities are far more extensive than any other computer, with joystick and keypad interfaces, sound output, an 8-bit D/A converter, 16 parallel I/O lines, modem and printer interfaces, AC remote control and security monitor interfaces and a universal accessory port that accepts a prom blaster, 12-bit analog I/O module, solderless prototyping board and more.

Ohio Scientific offers a large library of personal applications programs, including exciting action games such as Invaders and Star Trek, sports simulations, games of logic and educational games, personal applications such as biorhythms, calorie counter, home programs such as checking and savings account balancers and a home budgeter just to name a few. A new Plot BASIC makes elaborate animations easy, and music composition program allows you to play complex multi-part music through the computers DAC.

At the systems level the machine comes standard with OS-65D, an advanced disk operating system with Microsoft BASIC and an interactive Assembler Editor. Optional software includes UCSD PASCAL and FORTRAN and an Information Management System (OS-MDMS). Dozens of independent software suppliers now also offer personal programs for the C8P.



puter explorations.

Business Computer Features
The C8P DF utilizes dual 8" floppy disk drives which store up to eight times as much information as personal computer mini-floppies, and an available double-sided option expands capacity to 1.2 megabytes of on-line storage. The C8P DF is compatible with Ohio Scientific's business computer software, including OS-65U an advanced operating system, and an Information Management System (OS-DMS) with supplementary inventory, accounting, A/R-A/P, payroll, purchasing, estimation, educational grading and financial modeling packages. The system also supports word processing (WP-3) and a fully integrated small business accounting system (OS-AMCAP V1.6). The C8P DF's standard modem and printer ports accept high-speed matrix printers and word-processing printers directly.

Home Control and Industrial Control
The C8P DF has the most advanced home monitoring and control capabilities ever offered in a computer system. It incorporates a real time clock and a unique FOREGROUND/BACKGROUND operating system which allows the computer to function with normal BASIC programs, at the same time it is monitoring external devices. The C8P DF comes standard with an AC remote control interface, which allows it to control a wide range of AC appliances and lights remotely, without wiring, and an interface for home security systems which monitors fire, intrusion, car theft, water levels and freezer temperature, all without messy wiring. In addition, the C8P DF can accept Ohio Scientific's Votrax voice I/O board and/or Ohio Scientific's new universal telephone interface (UTI). The telephone interface connects the computer to any telephone line. The computer system is able to answer calls, initiate calls and communicate via touch-tone signals, voice output or 300 baud modem signals. It can accept and decode touch-tone signals, 300 baud modem signals and record incoming voice messages. These features collectively give the C8P DF capabilities to monitor and control home functions with almost human-like capabilities.

For process control applications, a battery back up calendar clock with automatic computer restart capabilities is available. Ohio Scientific's unique accessory ports allow the connection of a nearly unlimited number of 48 line parallel I/O cards and 12-bit high speed instrumentation quality analog I/O modules to the computer by inexpensive 16-pin ribbon cables.

Exploring New Frontiers
Ohio Scientific's vocalizer software processes normal BASIC print statements with conventional spellings and speaks them clearly in real-time on computers equipped with the UTI (CA-15B or CA-14A). This voice output capability, combined with the C8P's remote control, remote sensing, telephone interface capabilities and reasonable cost open up new frontiers for computer applications.

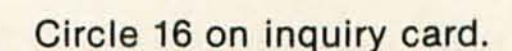
Documentation
The C8P DF is not a beginner's computer and doesn't come with beginner's documentation. However, Ohio Scientific does offer detailed documentation on the computer which is meaningful for experts, including a Howard Sams produced hardware service manual that includes detailed block diagrams, schematics, parts placement diagrams and parts lists. Ohio Scientific is now also offering fully documented Source Code in machine readable form for OS-65D, the Challenger 8P's operating system allowing experimenters and industrial users to customize the system to their specific applications.

What's Next?
Ohio Scientific is working on a speech recognizer to complement the UTI system, with a several hundred word vocabulary. The company is also developing an 8 megabyte low-cost, add-on hard disk for use in conjunction with natural language parsing to further advance the state-of-the-art in small computers. The modular bus architecture of the C8P assures system owners of being able to make use of these new developments as they become available just as the owner of a 1976 vintage Challenger can directly plug in voice output, the UTI and other current state-of-the-art OSI products.

The C8P DF with dual 8" floppies, BASIC and two operating systems costs about $3000, only slightly more than you would pay for a dual mini-floppy equipped personal computer with only a fraction of the capabilities of the C8P.

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Multimachine Games

Ken Wasserman and Tim Stryker
Mach 2 Software
96 Hammersmith Apts
Danbury CT 06810

There you are, staring into a poor dumb tube, spending hours trying to wheedle, cajole, flatter and coax your machine into coughing up a few more points, or maybe into reluctantly admitting every now and then: "YOU WIN!!!(bell)(bell)!!!" How much satisfaction is there in that, really? How much challenge? So you beat the computer. So what? So the computer beat you. Who cares? Do you ever long for a scenario something like the following?. . . .

Tonight will be the final, deciding match of the battle series—the winner will have won the regional computer-club title and will be eligible for the national playoffs next month in San Diego. As you and your worthy opponent, both dressed in black, enter the room, a hush falls over the gathered assembly. You approach your respective consoles, and, at a prearranged signal from the presiding judge, the game begins.

The screen before you contains a wealth of information about the status and positioning of your various forces. You have two "windows" onto the field of play, one centered on your base, the other on your current tank. You see no sign of your opponent or his base in either window, for the field of play is very large: you know that he is out there somewhere, but, as the game begins, you have no idea where.

As you begin to move your tank out of your base, you find that it stays centered in its own window, thereby making previously unseen portions of the field visible to you, while, from the point of view of your base (which is immobile) your tank appears to move away from window center until shortly it disappears off the edge. Quickly reconnoitering your base perimeter, you begin to lay down mines to protect it from invasion. (These mines are visible to you but not to your opponent, to whom a square filled with one of your mines looks just like a stretch of virgin grassland.) As you do this, the steady clickety-click you hear from your opponent's keyboard tells you that he is not exactly idle either—he is probably mining the area around his base.

Quickly reconnoitering your base perimeter, you begin to lay down mines to protect it from invasion.

Or perhaps his base is well protected by mountain ranges, and he is now already actively seeking yours? Or maybe he has decided on the decoy ploy, and is building and mining an entirely false base to confuse you? You have no way of knowing!

Running out of mines, you frantically return to your base to restock, then rush out again to complete the mining operation. Suddenly you hear the sound of a mine exploding. Has your opponent run across your mine field already? Or did he, in his own haste, run afoul of one of his own mines? Thankful you had the foresight to make your mine fields orderly, you investigate: one of them is missing! Your opponent's tank is now badly damaged, but there are still four more where that one came from, and, more important, he now has some idea as to where your base is.

Out of mines again, and unwilling to return to base to restock, you are unable to patch the breach—instead, you take off after the intruder, and suddenly—there he is! His tank appears within your tank window! You fire—and miss—he maneuvers, fires—and hits you!

Your tank goes into condition yellow—you maneuver, fire—and miss—fire again—a hit! His tank, which was in condition red from having hit the mine, is completely destroyed, but you know that the second of his supply of five tanks has now been made available to him back at his base, wherever that is. Quickly slipping into a nearby forest to survey the area, you suddenly run across what can only be his second tank!

You reason as follows: in order for his second tank to have gotten back to this area as fast as it did, his base

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must be nearby. Accordingly, you ignore the fact that his tank begins firing at you, opting instead to try to catch a glimpse of his base in your tank window before your tank is destroyed.

You maneuver—are hit!—your tank is now in condition red, and you find it difficult to move properly—nevertheless you forge ahead—there is his base! You move again, and hit a mine—your tank is destroyed! However, remembering the coordinates your tank was at when you saw his base, you make a lightning mental conversion from rectangular to polar coordinates, and, shouting insults across the room to distract your opponent's attention, you swiftly key the polar data into your angle and range registers and fire off an intercontinental ballistic missile from your base. A high, falling whistle is heard, followed by a colossal explosion.

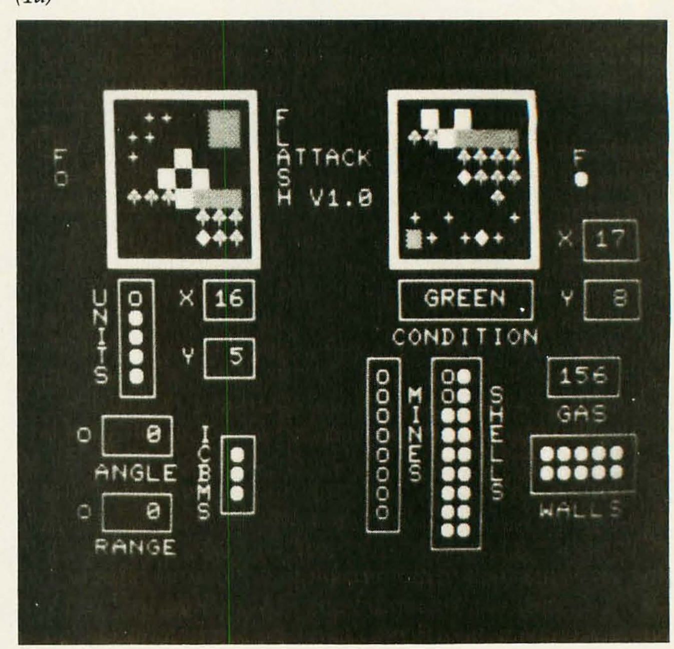
A deathly quiet ensues: your condition display glows with the word "SUPREME," while on your opponent's screen you know the condition to be "DEFUNCT." You have triumphed in the first game of tonight's seven-game match—as you glance across to see the look of fierce determination on the face of your opponent, you realize that the remaining games may not be won so easily. The judge, looking at both players, slowly raises his hands, and the second game begins. . . .

Creating a Game

The creation of such a game may not be as far beyond your capabilities as you might think: the above game, including all features mentioned, and more, has already been implemented for use on a pair of lowly 8 K-byte Commodore PET computers, under the name of *Flash Attack*. (See photos 1a and 1b.)

A pair of 16 K-byte PETs, TRS-80s, or Apple IIs should allow the development of even more outrageous games of this general type, perhaps involving quicksand pools, laser weaponry, or aerial reconnaissance, to name a few possibilities. The game could even conceivably be generalized to include more than two players, leading to situations in which teamwork and treachery could become determining factors in a game's outcome.

(1a)



(1b)

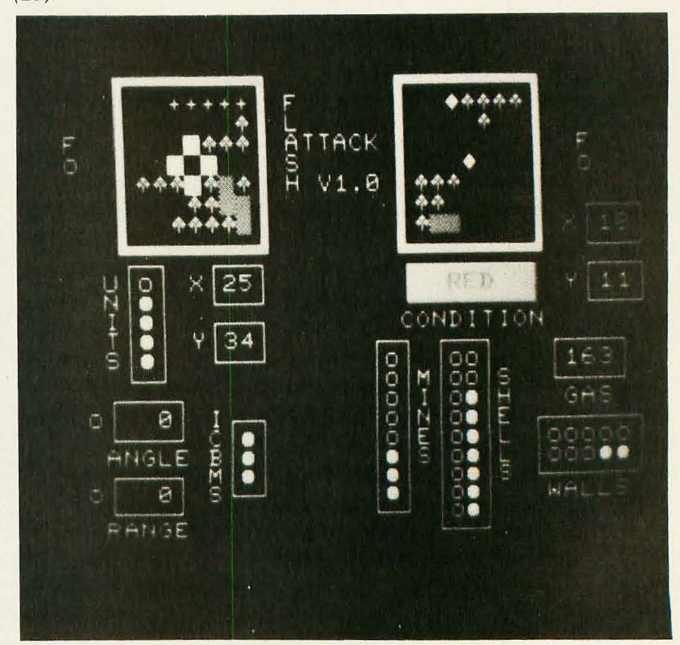


Photo 1: *A typical game of* Flash Attack *fully underway. The photos 1a and 1b show the display screens seen by each of the two players. The two rectangular "windows" seen on each screen represent a limited view of each player's base and the view from his active tank. By presenting only incomplete information to each player, the skill necessary (along with the corresponding sense of accomplishment) is increased.*

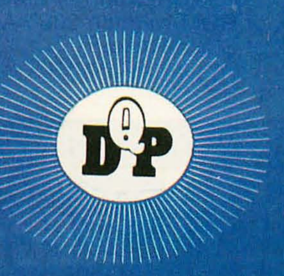
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The game hinges on the players' judicious use of incomplete information.

The basic factors that go into making a game like this interesting are threefold:

1. More than one human player is involved in the game. Rather than having the user compete against the machine, the machine is *utilized* to permit two or more people to compete with *each other* in ways that would be impossible without the aid of the machine.
2. Success in the game hinges on the players' judicious use of *incomplete information.* Although the game may, in fact, be entirely deterministic in the sense that each legal move a player proposes gets put into effect without the intervention of any randomizing influence, the fact that each player has only a limited notion as to what his opponents are up to lends a definite element of suspense and calculated risk-taking to the game.
3. The game is played in *real time:* one's options are constrained not so much by the rules of the game as by one's own fleetness of hand and mind (or lack thereof).

Many conventional board games, and virtually all conventional card games, embody factors 1 and 2. Many video pinball parlor games, such as Atari's *Pong* and *Tank*, embody factors 1 and 3, while most of the rest of the available microcomputer game software embodies either none of these factors (computer chess, backgammon, etc), factor 2 alone (*Star Trek*, *Adventure*, etc), or, in exceptional cases, factors 2 and 3 together (real-time *Star Trek*, etc).

It is interesting to note that, of all the major league sports, the one that embodies all three of these factors most fully is football—this may be the reason why the sport is so overwhelmingly popular.

Bringing all three of these factors together in a single computer game virtually *requires* that more than a single console be used. Since, to most of us, a requirement for multiple consoles is equivalent to a requirement for multiple machines, the issue that will be addressed here is: what is needed in the way of hardware and software to support the implementation of multimachine games?

Two-Machine Games

In the case of two-machine games, the answer turns out to be surprisingly simple and inexpensive. Most microcomputers come already supplied with a general-purpose, 8-bit, parallel I/O (input/output) port poking out the back someplace. For those that do not, an add-on port of this type can generally be purchased at nominal expense. As in the PET, the port should ideally have the property that, even though configured for output, it will still return a correct reading of the states of the pins involved when a "read" operation is performed on it.

Also, as with the PET, the port should represent the *high* state upon output by means of a passive pull-up resistor. Ports not satisfying these conditions may still be



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Listing 1: *Listing of the program used to test the cable described in figure 1.*

```
100 REM*** PROGRAM TO TEST INTER-
110 REM***     MACHINE COMMUNICATIONS
120 REM***
200 GOSUB 10000
210 IF PEEK(59471) AND 16 THEN 260
220 GET S$
230 IF S$ = "" THEN S$ = CHR$(0)
240 GOSUB 10200
250 IF S$ = "●" THEN 999
260 GOSUB 10400
270 PRINT R$;
280 IF R$ <> "●" THEN 220
999 END
10000 REM***
10010 REM*** ROUTINE TO INITIALIZE PORT
10020 REM*** INPUTS: NONE
10030 REM*** OUTPUTS: NONE
10040 REM***
10050 POKE 59471,255
10060 POKE 59459,255
10070 RETURN
10200 REM***
10210 REM*** ROUTINE TO SEND BYTE
10220 REM*** INPUT: S$ = BYTE TO BE
10230 REM***             SENT
10240 REM*** OUTPUTS: NONE
10250 REM***
10260 HN = INT(ASC(S$)/16)
10270 LN = ASC(S$)-HN*16
10280 POKE 59471,LN+128+32
10290 IF PEEK(59471) AND 128 THEN 10290
10300 POKE 59471,HN+128+64
10310 IF PEEK(59471) AND 128 THEN 10330
10320 GOTO 10310
10330 POKE 59471,255
10340 RETURN
10400 REM***
10410 REM*** ROUTINE TO RECEIVE BYTE
10420 REM*** INPUTS: NONE
10430 REM*** OUTPUT: R$ = BYTE RECEIVED
10440 REM***
10450 IF PEEK(59471) AND 64 THEN 10450
10460 LN = PEEK(59471) AND 15
10470 POKE 59471,127
10480 IF PEEK(59471) AND 32 THEN 10480
10490 HN = PEEK(59471) AND 15
10500 POKE 59471,255
10510 R$ = CHR$(HN*16+LN)
10520 RETURN
```

used as long as there is provision made within them for individually programming each bit position to be either input or output (examples of the use of such ports will not be given here).

What is needed, then, is an arrangement that will allow a byte at a time to be transferred from either machine to the other. Figure 1 gives the wiring diagram for the cable needed; as you can see, each bit position on each machine is simply directly connected to the corresponding bit position on the opposite machine. This is true for all bits except for the 2^4 bit, labeled ASYM, which is grounded on one machine and left floating *high* on the other. The whole package, including connectors, should cost less than $5.

Listing 1 contains a program designed to test the cable. It is designed for use on a pair of PETs, but, with minor modifications, it should be capable of supporting any pair of machines with ports satisfying the conditions discussed above. With the cable in place, and with both machines running this program, what should happen is that any keys hit on either machine should be displayed on the screen of the other. Type a shift-Q (*not* the STOP key) to exit the program and return to BASIC.

The three utility routines of interest here start at lines 10000, 10200, and 10400, respectively. The routine at line 10000 simply initializes the port: location 59471 is the PET's User Port I/O data register, while 59459 is the register used to configure the data pins for input and output. The POKE in line 10060 configures all eight pins as output.

The SEND routine at line 10200 may be called whenever it is desired to send a byte to the opposite machine. However, the opposite machine must call its own RECEIVE routine, at line 10400, in order for the transfer to take place. There is a potential pitfall here: if, when writing your own code to use these routines, you create a situation in which both machines are trying to send a byte to the other at the same time, or if both machines try to receive a byte from the other at the same time, both will "hang."

The programs running on the two machines must be set up in such a way that whenever one of them decides to send a byte, the other realizes this and sets up to receive it. Given this fact, the purpose of the ASYM bit in figure 1 becomes evident: it guarantees that start-up problems will not arise when running identical copies of a single program in both machines. Consider yourself in the position of the program in listing 1 as you begin running; eventually you would reach the point where you would like to start up a dialogue with the other machine.

Question: should you send a byte to the other machine first, or receive one? You and the other machine had better come to complementary conclusions as to which to do first. Solution: you use the setting of the ASYM bit to decide. This is exactly what happens in line 210 in the listing. If, upon reading the port contents, you find that the 2^4 bit is *high*, you receive first; otherwise you send first. From that point on, in this example, you simply alternate sending and receiving, and everything is fine.

Let's take a closer look at what is actually involved in transferring a byte using this scheme. The nine lines shown in figure 1 can be broken down into four *groups:*

- GND. This is a signal ground, which must be present in



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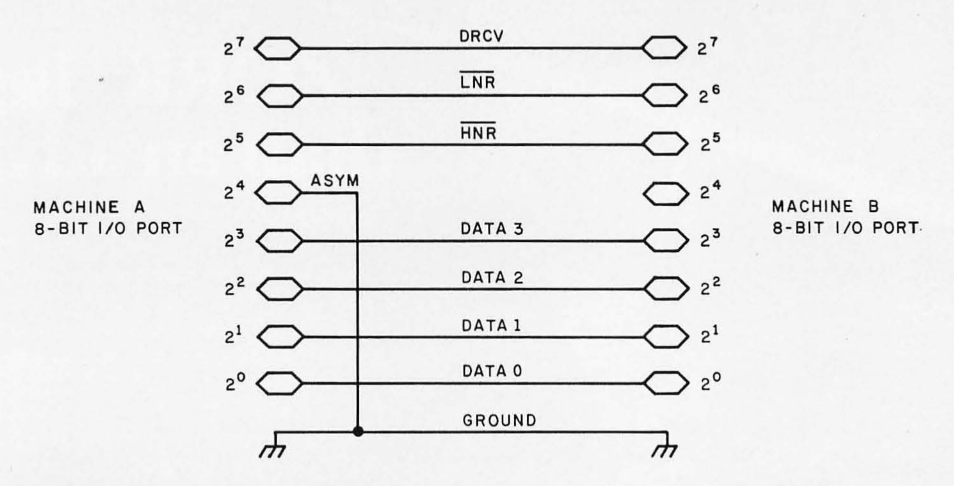


Figure 1: *The cable arrangement needed for connecting two PETs in game-playing configuration. Each machine runs the same program, and exchanges relevant information, one byte at a time, with the opponent's computer. The bit labeled 2^4 determines the initial state of each machine and, thus, whether it first transmits or receives.*

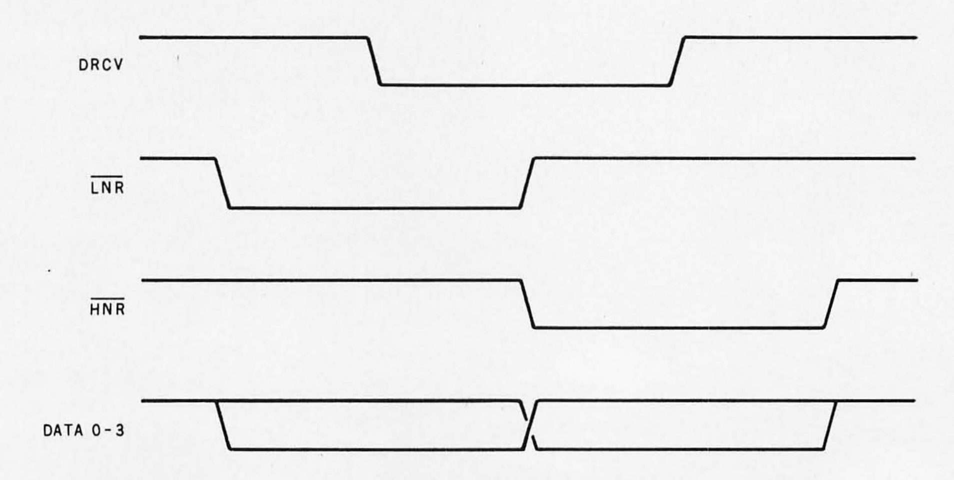


Figure 2: *Timing diagram for information transfer using the cable scheme of figure 1. The transmitting computer puts information on the DATA lines, low-order nybble first, and brings the LNR line low. The receiving computer brings the DRCV line low when the information has been accepted. The process is repeated for the high-order nybble, but HNR is used to indicate the presence of new data. When DRCV is brought high, the transmitter and receiver functions reverse.*

order for the two machines to have a common reference voltage.

- DATA 0 thru 3. These lines, which are controlled by the sender, carry the actual data being transferred, a nybble at a time (a nybble is half of a byte, or 4 bits).
- ASYM. This has already been discussed.
- DRCV, LNR, and HNR (data received, low-order nybble ready, and high-order nybble ready). These are the so-called "handshake" lines. LNR, which is a signal from the sender to the receiver, is brought *low* by the sender to indicate to the receiver that the low-order nybble of the byte being sent is now ready to be read off of the DATA lines. HNR, also a signal from the sender to the receiver, is brought *low* by the sender to indicate to the receiver that the high-order nybble of the byte being sent is now ready to be read off the DATA lines.

DRCV, which is a signal from the receiver to the sender, is brought *low* by the receiver once he has read the low-order nybble off of the DATA lines, to indicate to the sender that he is ready for the high-order nybble; DRCV is then brought *high* again by the receiver once he has read the high-order nybble off of the DATA lines, to indicate to the sender that the high-order nybble has been received and that, as far as the receiver is concerned, the transaction is complete.

Figure 2 shows a timing diagram of the whole operation. Essentially, what happens is this:

The sender puts the low-order nybble on the DATA lines, and (by bringing LNR *low*) says, "Here is the low-order nybble." The receiver reads in the low-order nybble, and (by bringing DRCV *low*) says, "I've got it." The sender then puts the high-order nybble on the DATA lines, and (by bringing LNR *high* and HNR *low*) says, "Here is the high-order nybble." The receiver reads in the high-order nybble, combines it with the low-order one to make a complete byte, and (by bringing DRCV *high* again) says, "All set. Goodbye." The sender must then return all lines to the *high* state before returning to his caller.

All lines are left in the *high* state except when actually in use so that if one machine tries to send or receive while the other is off doing something else, the first machine will simply wait until the other is ready before proceeding



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with the transfer.

The only modifications necessary for this scheme (to handle ports lacking the previously discussed properties) would be: to have code at the beginning of the RECEIVE routine which configured the DRCV line for output and the remaining lines for input; to have code at the beginning of the SEND routine that configured the DRCV line for input and the remaining lines for output; and to have code at the ends of both routines for reconfiguring all lines as input. The port initialization routine would also have to be changed to initially configure all lines for input so that the ASYM bit could be sensed properly.

Although code resembling that shown in listing 1 works, it executes excruciatingly slowly under most current implementations of BASIC. Anyone considering writing a real-time game using these routines would be well advised to rewrite, at a minimum, the SEND and RECEIVE routines in machine language. Listing 2 shows a program, tailored for the PET, which is functionally identical to the one in listing 1: the difference is that in listing 2 all three utility routines have been implemented in machine code.

The subroutine at 10000 now sets up the machine code in the PET's "tape-2 buffer"—the SYS to 909 in line 200 is what actually initializes the port. The USR function is invoked with a negative argument (as in line 240) to cause the machine to execute the RECEIVE software . . . the value returned by USR is that of the byte received.

When the argument to the USR function is nonnegative (as in line 230), its value is turned over to the SEND software for transferrence to the other machine . . . under these conditions the value returned by USR is garbage. The ASYM bit must still be checked from BASIC to determine whether to send first or receive first. (See line 210.)

Listing 2: *Functionally the same as listing 1, this program is tailored for the PET computer and has several utility routines implemented in machine code.*

```
100 REM*** PROGRAM TO TEST INTER-
110 REM***    MACHINE COMMUNICATIONS
120 REM***    USING MACHINE LANGUAGE
130 REM***    AND OTHER EFFICIENT
140 REM***    PROGRAMMING TECHNIQUES
150 REM***
200 GOSUB10000:SYS909
210 IFPEEK(59471)AND16THEN240
220 GETS$:S=0:IFLEN(S$)>0THENS=ASC(S$)
230 U=USR(S):IFS$="■"THEN999
240 R$=CHR$(USR(-1)):PRINTR$;
250 IFR$<>"■"THEN220
999 END
10000 REM*** THIS ROUTINE SETS UP THE
10010 REM***    FOLLOWING FACILITIES
10020 REM***    IN MACHINE LANGUAGE:
10030 REM***
10040 REM***    SYS909 ...INITS PORT
10050 REM***
10060 REM***    U=USR(+N) ...SENDS N
10070 REM***
10080 REM***    U=USR(-1) ...RECEIVES U
10090 REM***
10100 FORI=826TO917:READX:POKEI,X:NEXT
10110 POKE1,58:POKE2,3
10120 IFPEEK(50003)=0THENRETURN
10130 POKE827,154:POKE830,97:POKE834,98
10140 POKE869,109:POKE882,98:POKE903,98
10150 RETURN
11000 DATA 32,167,208,166,179,208,32
11010 DATA 165,180,72,9,240,41,191,141
11020 DATA 79,232,104,74,74,74,74,9
11030 DATA 208,44,79,232,48,251,141,79
11040 DATA 232,44,79,232,16,251,48,44
11050 DATA 32,103,3,76,120,210,44,79
11060 DATA 232,112,251,173,79,232,41,15
11070 DATA 133,180,169,127,141,79,232
11080 DATA 169,32,44,79,232,208,251,173
11090 DATA 79,232,10,10,10,10,5,180,168
11100 DATA 234,234,169,0,162,255,142,79
11110 DATA 232,142,67,232,96
```

Putting It All Together

Just having the capability to transfer bytes back and forth between two machines does not guarantee success in writing multimachine games. We now need a general strategy for controlling the flow of information between the various machines in such a way that the moves made by each player are processed in a consistent manner by all machines involved. Among other things, the strategy used must ensure that all of the machines involved agree as to the order in which the various players' moves are to be processed. Only one such strategy, the key-oriented strategy, will be discussed here. Although many other approaches to the problem do exist, this one is particularly "clean" and therefore easily debugged; it is also reasonably efficient in both space and time.

The information transfers addressed by any general strategy of this kind fall into two groups: those that occur at initialization time and those that occur during the actual play of the game. The key-oriented strategy calls for all information pertinent to the initial state of the game, including information that may be kept secret from one or more players, to be made known to all machines at initialization time.

Then, during play, a continuous conversation is set up among the machines in which the only information changing hands consists of individual keystrokes generated by the players at their keyboards. If a player generates no keystroke to be sent on a given pass, a zero byte is sent out to the other machine(s) to indicate this fact. Every machine maintains the full status of every player but only displays the information its own player is supposed to see.

Listing 3 shows a program, Real-Time Two-Machine Hangman, designed to illustrate the use of the key-oriented strategy. To keep it short, such things as instructions, gruesome representations of gallows, and so on have been left out. The object of the game is not, as it is in normal Hangman, to guess your opponent's word within a set number of letter-guesses while he sits around *telling* you where your correct guesses fit in. Instead, both you and your opponent choose words that the other tries to

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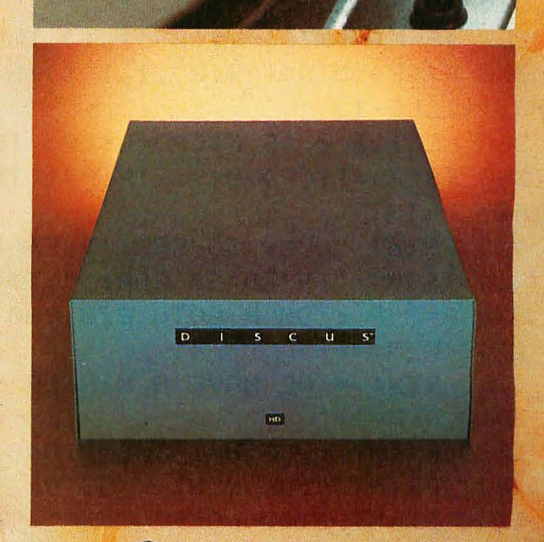
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guess—whoever guesses the other's word first wins.

The program as shown is, of course, only capable of running on a pair of PETs. However, with suitable alteration of the SEND/RECEIVE software, it should be possible to run it on any pair of common microcomputers possessing the cabling arrangement described above.

Game Time

To play the *Hangman* game, attach the cable, type the program in, and RUN it on both machines. You and your

Listing 3: Real-time Two-Machine Hangman *in which you attempt to guess your opponent's chosen word first.*

```
10 REM*** REAL-TIME 2-MACHINE HANGMAN
20 REM***
30 REM***  W$... THE TARGET WORDS
40 REM***  F$... LETTERS FOUND SO FAR
50 REM***  T$... LETTERS TRIED SO FAR
60 REM***
90 DIM W$(2),F$(2),T$(2)
100 GOSUB 10000 : SYS 909
110 PRINT "WHAT IS YOUR WORD";
120 INPUT W$(1)
130 IF PEEK(59471) AND 16 THEN 190
140 LS=USR(-1) : U=USR(LEN(W$(1)))
150 IF LS<>LEN(W$(1)) THEN 210
160 GOSUB 5100 : GOSUB 5000
170 GOSUB 5200 : P=2 : GOTO 280
190 U=USR(LEN(W$(1))) : LS=USR(-1)
200 IF LS=LEN(W$(1)) THEN 230
210 PRINT "WORDS ARE NOT SAME LENGTH"
220 GOTO 110
230 GOSUB 5000 : GOSUB 5100
240 GOSUB 5200 : P=1
250 REM***
255 REM*** MAIN PROCESSING LOOP
260 REM***
270 M$=CHR$(USR(-1)) : GOTO 300
280 GET M$ : M$=MID$(M$+CHR$(0),1,1)
290 U=USR(ASC(M$))
300 IF M$=CHR$(0) THEN 500
310 FOR I=1 TO LS
320 IF M$<>MID$(W$(P),I,1) THEN 360
350 F$(P)=MID$(F$(P),1,I-1)+M$+MID$(F$(
P),I+1,LS-I)
360 NEXT I : IF F$(P)=W$(P) THEN 1000
390 T$(P)=T$(P)+M$ : IF P=1 THEN 500
400 PRINT
410 PRINT "WORD SO FAR: ";F$(2)
420 PRINT "TRIED SO FAR: ";T$(2)
500 P=3-P : ON P GOTO 270,280
1000 REM***
1005 REM*** WE HAVE A WINNER
1010 REM***
1020 PRINT : IF P=1 THEN 1040
1030 PRINT "YOU WIN" : GOTO 1100
1040 PRINT "YOU LOSE"
1100 PRINT "THE MAGIC WORD WAS: ";W$(2)
1110 END
5000 REM*** ROUTINE TO SEND ENTIRE WORD
5005 REM***     TO OTHER MACHINE
5010 REM***
5020 FOR I=1 TO LS
5030 U=USR(ASC(MID$(W$(1),I,1)))
5040 NEXT I : RETURN
5100 REM***
5105 REM*** ROUTINE TO RECEIVE ENTIRE
5110 REM***     WORD FROM OTHER MACHINE
5115 REM***
5120 FOR I=1 TO LS
5130 W$(2)=W$(2)+CHR$(USR(-1))
5140 NEXT I : RETURN
5200 REM***
5205 REM*** ROUTINE TO INITIALIZE BOTH
5210 REM***     F$ ENTRIES TO ALL DASHES
5215 REM***
5220 FOR I=1 TO LS
5230 F$(1)=F$(1)+"-" : F$(2)=F$(2)+"-"
5240 NEXT I : RETURN
10000 REM*** THIS ROUTINE SETS UP THE
10010 REM***    FOLLOWING FACILITIES
10020 REM***    IN MACHINE LANGUAGE:
10030 REM***
10040 REM***    SYS909 ...INITS PORT
10050 REM***
10060 REM***    U=USR(+N) ...SENDS N
10070 REM***
10080 REM***    U=USR(-1) ...RECEIVES U
10090 REM***
10100 FORI=826TO917:READX:POKEI,X:NEXT
10110 POKE1,58:POKE2,3
10120 IFPEEK(50003)=0THENRETURN
10130 POKE827,154:POKE830,97:POKE834,98
10140 POKE869,109:POKE882,98:POKE903,98
10150 RETURN
11000 DATA 32,167,208,166,179,208,32
11010 DATA 165,180,72,9,240,41,191,141
11020 DATA 79,232,104,74,74,74,74,9
11030 DATA 208,44,79,232,48,251,141,79
11040 DATA 232,44,79,232,16,251,48,44
11050 DATA 32,103,3,76,120,210,44,79
11060 DATA 232,112,251,173,79,232,41,15
11070 DATA 133,180,169,127,141,79,232
11080 DATA 169,32,44,79,232,208,251,173
11090 DATA 79,232,10,10,10,10,5,180,168
11100 DATA 234,234,169,0,162,255,142,79
11110 DATA 232,142,67,232,96
```

opponent will each be asked to enter a word—if the words entered are of different lengths, the program prints an error message and reprompts both players for new words. Once the program has accepted the two words, any key you strike is taken to be a letter-guess directed at your opponent's word.

Each time you hit a key, your machine displays the results of your guess—that is, your target word so far, with dashes in the positions corresponding to letters not yet guessed, and a tabulation of the letters you have tried so far. The program automatically detects when one player has guessed every letter in his opponent's word, and declares the winner accordingly.

The initialization phase of listing 3 encompasses lines 10 thru 240 and all of the subroutines appearing from line 5000 on up. During this phase, the program POKEs the machine-language software into place, initializes the port to the other machine, and then (in line 110) prompts its *own player* for input and reads the reply into W$(1).

Then, using the ASYM bit as usual to determine whether to send first or receive first, it essentially exchanges word lengths with the other machine and checks to make sure that the two word lengths are equal. Once satisfied that they are, the program proceeds to exchange words with the other machine (using the subroutines at 5000 and 5100), placing the other player's word into W$(2). Both machines now know both players' words. Each machine has its own player's word in its own copy of W$(1) and the opposing player's word in its own copy of W$(2).

The Play Phase

At this point, the program is ready to enter the play phase, but first it must set the initial value of the *player select* variable P to either 1 or 2, depending on the setting of the ASYM bit. The reason for this is that the section of code from line 300 to line 500 is used to process proposed letters, or moves originating from *both* players—this is the essence of the key-oriented strategy. The variable P, which flips back and forth during play between 1 and 2 via the statement "P=3−P" in line 500, is used on each pass to determine whether to attempt to get a keystroke from one's own keyboard (which is what the GET statement in line 280 does) or to receive from the other machine the result of its attempt to get a keystroke from its own keyboard (which is what the assignment in line 270 does).

The value of P is also used in the main processing loop as the index into each of the two-element arrays W$, F$, and T$, to ensure that the proper player's status is updated as a result of the processing of the keystroke. The net implication is that P must be initialized to 1 on one machine and to 2 on the other so that the play phase will begin correctly.

During the play phase, then, the program simply circulates in the main processing loop shown, alternating the value of P back and forth between 1 and 2 on each pass. When P is 2, the machine's own keyboard is interrogated, the resulting keystroke (or a zero if the resulting keystroke was null) is sent off to the other machine, and the keystroke is processed by examining W$(2) for occurrences of it. F$(2) and T$(2) are updated accordingly and, in lines 410 and 420, are printed out.

When P is 1, the keystroke to be processed comes from the other machine (in order for this to happen the other machine's copy of P will at this point be equal to 2). The keystroke is processed by examining W$(1) for occurrences of it, and F$(1) and T$(1) are updated but not printed out, since they are of interest only to the player on the other machine.

Checking for the end-of-game is thus very simple: as soon as F$(P) becomes equal to W$(P), the game is over, and the value of P for which this was the case can be used (as it is in line 1020) to determine who won.

This is how a typical real-time two-machine game involving incomplete information is implemented. Other good candidates for implementation in this manner would be *Star Trek*, *Kriegspiel* (a version of chess in which neither player is ever entirely sure just where his opponent's pieces are located), and *Stratego*. You can easily design entirely new Adventure games, a submarine battle for example, using the basic approaches given here. The possibilities are certainly more exciting and creative than playing *Battleship* with pencil and graph paper. ■

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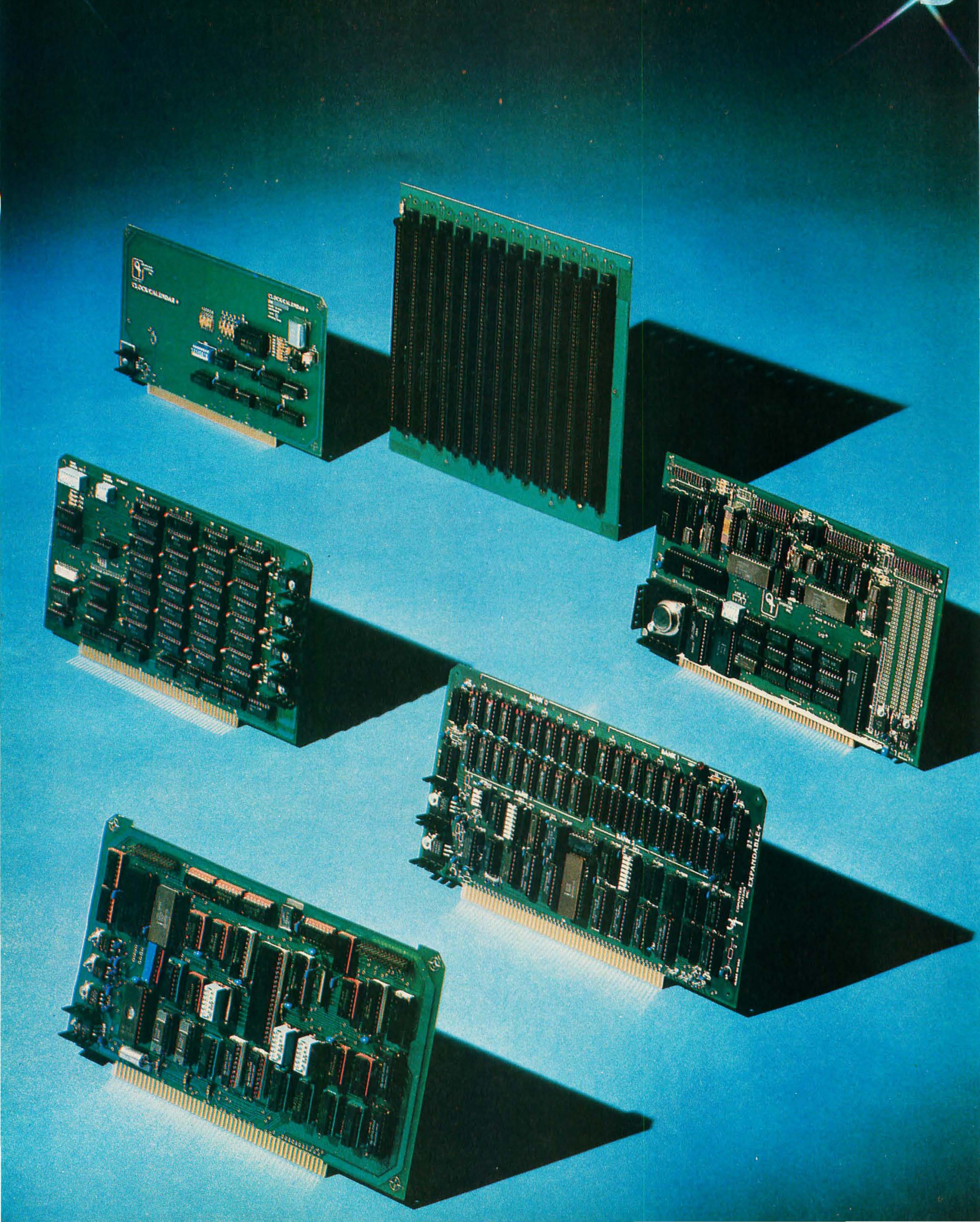
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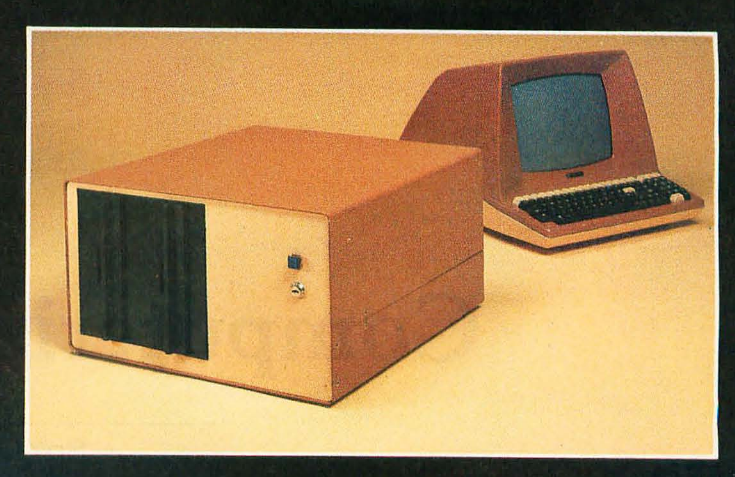
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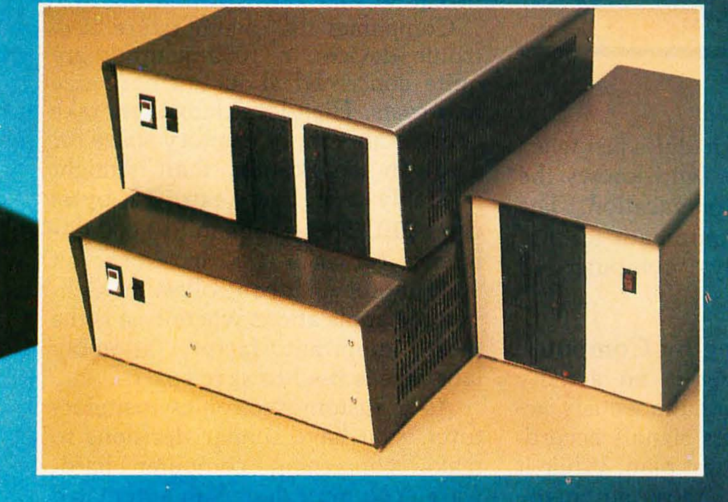
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The controller board in question has ten inputs and ten outputs. When a particular input signal is received (perhaps from the copy button), the controller activates one or more outputs, waits a preset time limit, and then changes the output. Depending upon the input-signal combination, the sequence may have one to five steps. The timing intervals can also vary within each sequence.

Without going into too much detail, it is easy to see that what we are discussing could prove to be a nightmare to test. It could conceivably be done manually in perhaps 2 or 3 hours with a maze of switches, indicators, and wires. With 1000 of them to build, it would take the services of two workers, and only six units could be shipped a day. (If you are *lucky*, you won't have to deliver 1000 controllers in 3 months.)

If you have any business sense at all, you know that such a situation is worth avoiding. (Customers have a habit of changing schedules just when the only technician who knows the test procedure goes on vacation.) The obvious solution is automatic testing, or more explicitly, computerized testing.

> The general industry practice of estimating software cost results in a cost of $20 to $40 per line of finished code.

Automated Testing by Computer

Automated testing is an activity where a machine simultaneously activates and monitors signals according to a prescribed test plan. While it is not a necessity, most automatic testers incorporate microcomputers because of the cost advantages and flexibility they impart to the tester. Microcomputers replace bulky relays and hardwired logic in older designs. The latest economically priced units are in fact nothing more than a basic computer with some specialized front-end interfacing.

In many applications, it is cheaper to configure your own test system and program it for a specific application rather than buy a "board tester." In our photocopy-board example, the hardware for ten input and ten output bits is relatively inexpensive. The application program to do the testing requires some thought, however.

There are two ways to write software for automatic test and controller applications. One is to use assembly language, and the other is to use a high-level language such as BASIC, tiny-c, or FORTH.

Companies that manufacture electronic devices in 1000-quantity are quite concerned about memory size and costs. High-level languages take considerably more memory space for a given application than straight assembly code. Every extra 1 K bytes costs $10. This results in $10,000 difference for each 1 K increment on 1000 photocopier controllers. In high-volume applications where cost is the most important factor, assembly language is used to save space.

As a custom-electronics manufacturer, you have similar decisions to make concerning computer hardware. You must design an automated device to efficiently test the photocopier controller. Unfortunately, you are building only one unit and will not have the large production volume over which to amortize the software-development costs. Your only choice is to risk becoming uncompetitive by raising the price of assembling each controller board. Therefore, it is in your best interests to keep these testing costs low.

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sionals discover this only after buying computers.) The general industry practice of estimating software is to charge at the rate of one line of code per hour regardless of the language used. This results in a cost of $20 to $40 per line. You may write ten lines of code in the first hour, but with all the documentation, debugging, and testing involved, one per hour is realistic by the time the application is thoroughly finished.

For a high-level language such as BASIC, the average line-for-line coding-time comparison is about 10 to 1 over assembly language. As much can be accomplished with a single IF . . . THEN . . . ELSE statement as ten or fifteen assembly-language instructions. For limited production items, or one-of-a-kind applications, where one line of high-level code costs no more than one line of assembly code, it is more reasonable to consider the former.

The major limitation of high-level languages such as BASIC is that they are interpretive and slow (2 to 5 ms per line). They require a fixed block of code (2 K bytes for a tiny BASIC to 24 K bytes for a fully extended disk version) to interpret and execute any amount of program statements in addition to the memory containing the user program. The size of the interpreter depends upon the sophistication of the instruction repertoire.

"Slow" is a relative term. If you need to activate a signal only 10 times a second, then there is no conflict. Doing something 500 times a second is more involved. As the interpreter code is reduced in size and complexity, the processing speed is increased. In its bare-bones state, a tiny BASIC has only integer arithmetic, no alphanumeric string-handling capability, limited array-handling capability, and limited math functions. But it is fast by comparison to fully extended high-level languages. If full processor speed is required in some portions of the application, one or more special assembly-language subroutines can be called and executed from the high-level language program, which takes over again at the conclusion of the assembly-language subroutine.

An Actual Automatic Tester Application

In "I/O Expansion for the TRS-80," Parts 1 and 2 (Ciarcia's Circuit Cellar in the May and June 1980 BYTE, pages 22 and 42, respectively), I presented an article on the design of a serial/parallel I/O (input/output) interface for the TRS-80 called the COMM-80. (A block diagram of the interface is shown in figure 1.) I have received an influx of reader inquiries concerning component sources and terminal software. This leads me to believe many people are building the interface.

This assumption, as well as a need to have a good diagnostic program for any computer peripheral in production, prompted me to design the hardware and software necessary to automatically test a COMM-80. In addition to providing anyone who has constructed the interface with a useful test program, the resulting effort fully demonstrates use of a high-level language in a test/control application.

Reviewing quickly, the COMM-80 is an interface designed specifically for the TRS-80 (it can be attached to any 8-bit computer with a bidirec-

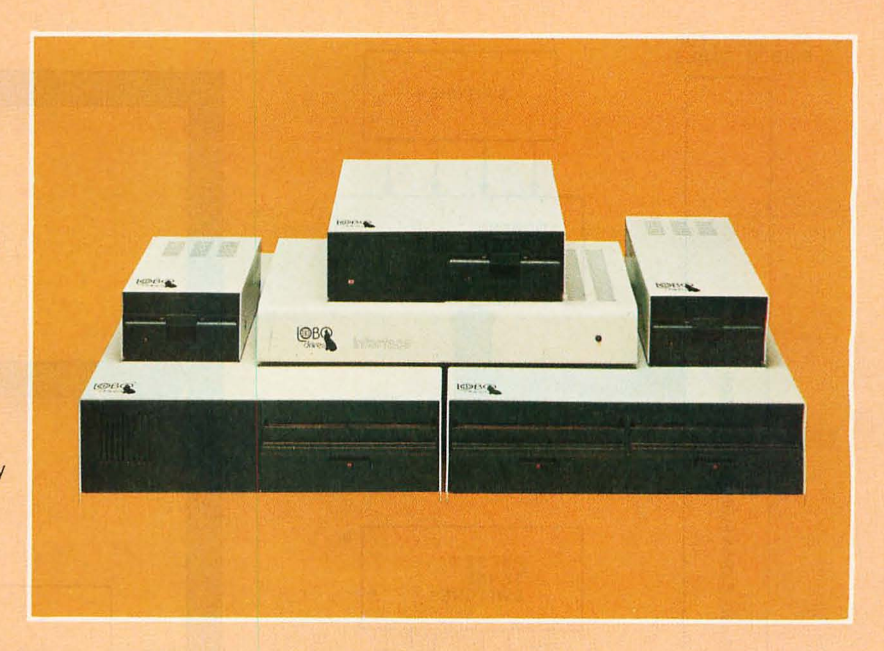
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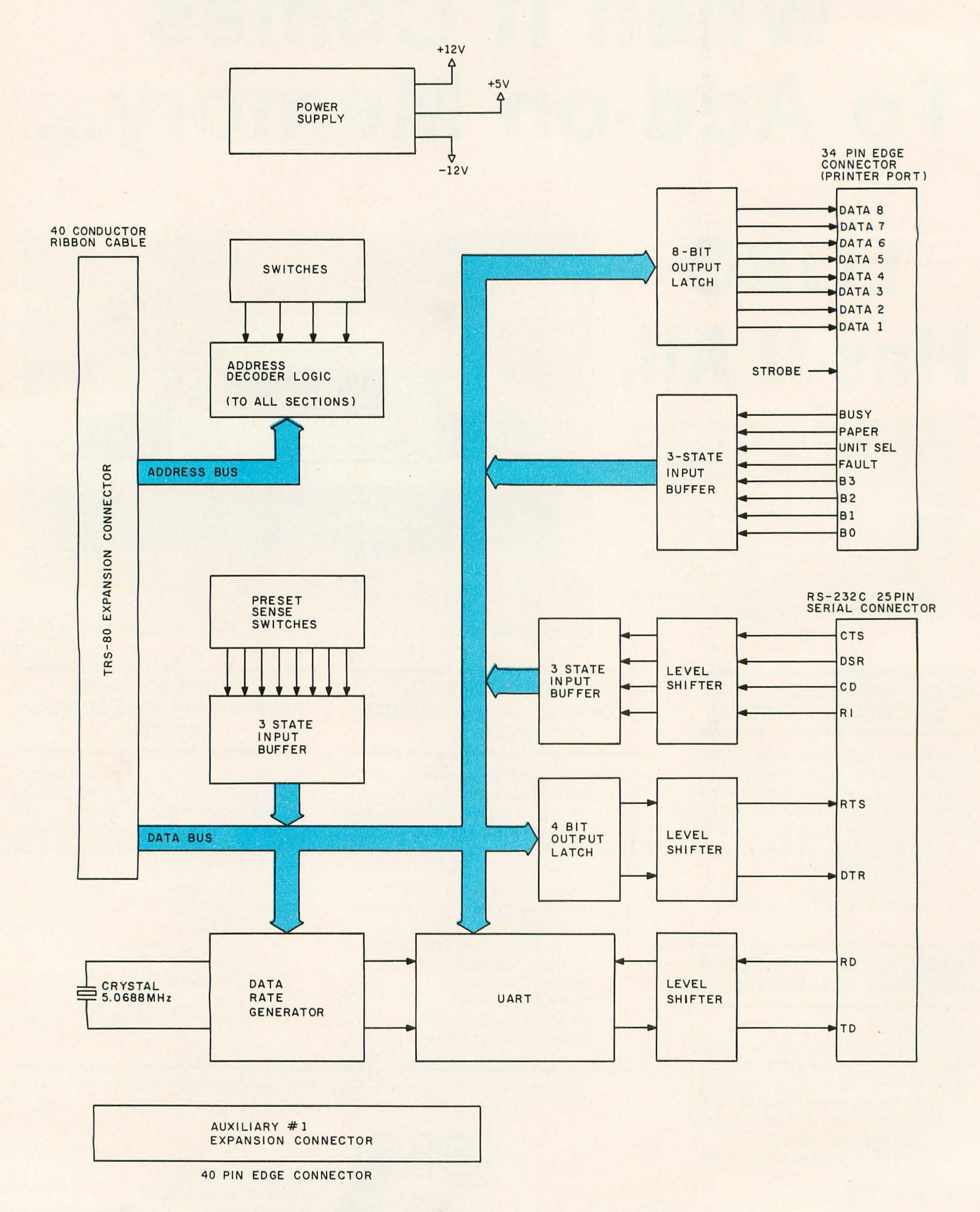
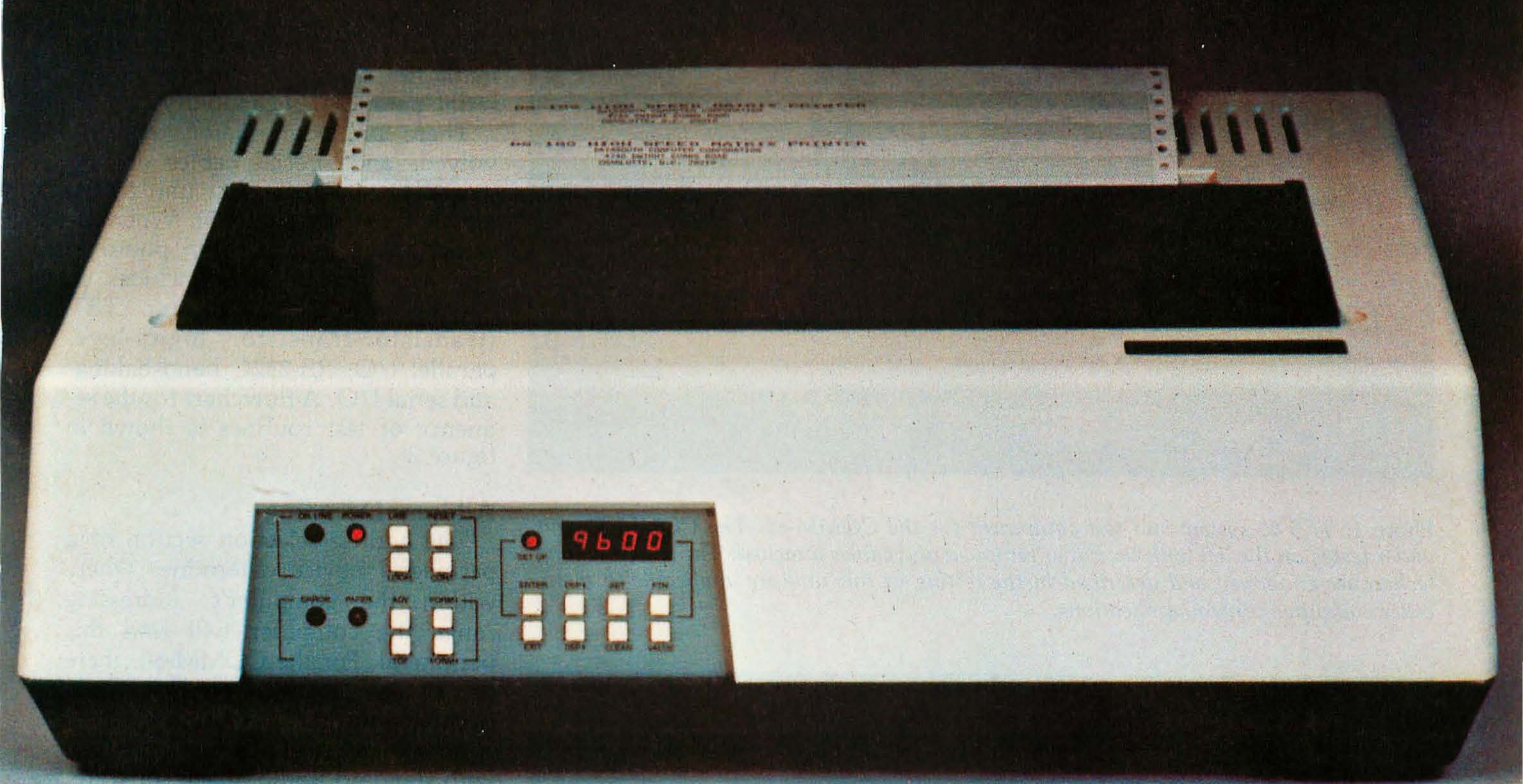


Figure 1: *Block diagram of the COMM-80 I/O interface showing the interrelationship of the signals.*

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Text continued from page 46:
tional data bus). It contains a software-programmable serial port and an 8-bit parallel I/O printer port. It has variable-address selection and full RS-232C handshaking capability. The variety of options makes for a lengthy test when done manually.

The Test Sequence

As I previously mentioned, most automatic testers consist of a microcomputer and some front-end interfacing hardware. In this application, I chose to use the TRS-80 as the test computer for obvious reasons, but the software is written so that it can be executed on most similar BASICs. The front-end equipment, consisting of a serial and parallel port, is coincidentally another COMM-80 that is set at an address different (hexadecimal 37F8) from the test unit. When the test unit is exercised, the computer reads the results through the second (master) unit. The entire computer configuration is shown in photo 1. The second unit is required only to provide the automatic test computer with the proper serial/parallel I/O capability.



Photo 1: *TRS-80 system and test equipment for the COMM-80. The COMM-80 unit under test is on the left with the cover removed and cables attached. The programming techniques employed and described in the testing of this unit are applicable to many other computer-control applications.*

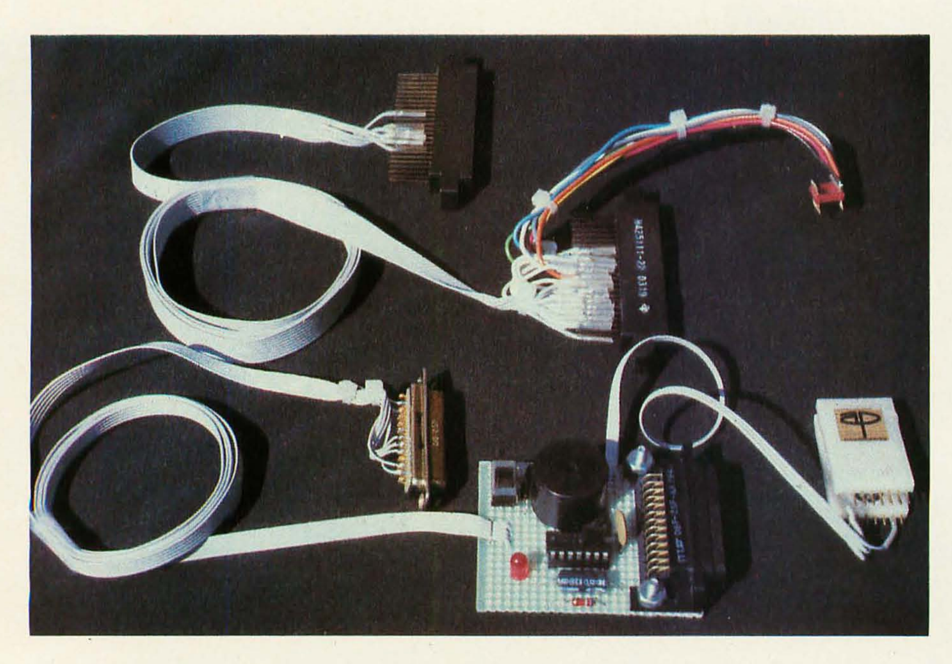


Photo 2: *Test cables required to run diagnostics on a COMM-80 serial/parallel I/O interface. The cable on the top (from figure 3) connects the test-unit printer port to the master-unit printer port. The 8-bit parallel output is also wired to a sixteen-pin dual-inline plug header to test the programming-plug input.*

The cable on the bottom (from figure 6) connects the test unit RS-232C signals to the master unit's RS-232C port. The prototyping board contains a beeper that is triggered when the computer outputs data through the test-unit printer port.

There are four major tests involved, and special cables are required to attach the test unit to the master unit (see photo 2). When attached, they appear as in photo 3. The sequence of tests includes in order: address decoding, TTL (transistor-transistor logic)-level parallel I/O, RS-232C handshaking, and serial I/O. A flowchart for the sequence of test routines is shown in figure 2.

Address Decoding

The address-selection section of a peripheral device determines where within the computer's addressing range the computer will find this peripheral. For the COMM-80, there are sixteen locations between hexadecimal locations 3708 and 37F8 to which it can be set. To be compatible with standard Radio Shack software, the setting should be 37E8. Generally speaking, the failure in address decoders is usually the *switch* and not the *logic*. It is not enough to set the unit for address 37E8 and presume that, if it works, the rest of the addresses will. All sixteen addresses need not be checked, but each one of the 4 selectable address bits should be cycled. My preference is to check six combinations: all on, all off, and one on at a time. The only way to determine if they work is to successfully accomplish I/O communication at each address.

Figure 3b is a diagram of a circuit that facilitates this test. It is a simple one-quarter-second beeper that is activated by the 1 μs printer output-strobe pulse. Only the address-decoder circuitry and the 74121 (IC16) strobe-pulse generator on the COMM-80 board are involved. If a test unit is set for an address of 37E8,

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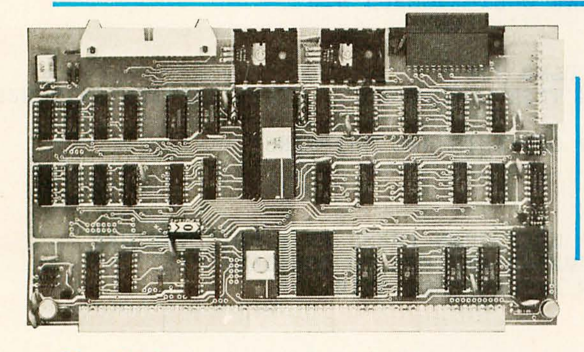
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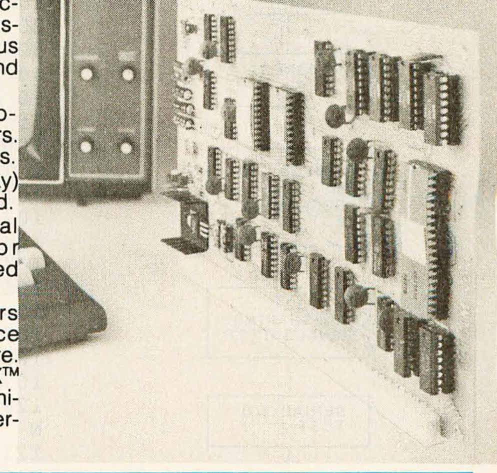
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the beeper will sound every time the computer writes data to that address. In addition to providing a method for testing the address decoder, the beeper serves as an audible indicator during other test sequences.

An integrated-circuit test clip facilitates access to +5 V (to power the beeper). It also conveniently picks up the strobe pulse and provides ground, even though they are available on the printer connector. The beeper circuit is completely independent of the other cables, but it is constructed on a board attached to the RS-232C connector, for convenience.

Figure 4 charts the test sequence, and listing 1 contains the actual code. This software, as well as that of the other tests, is designed as an independent subroutine to allow multiple passes.

Initially, all switches are set to the open position (hexadecimal address 37F8), and the computer attempts to write to the printer at port 37F8. If the address decoder works, the beeper should sound continuously. If not, there is a problem. Once continuous beeping is achieved, reset the address switches (as shown in photo 4) to hexadecimal address 3778 and press the @ key. This action tells the computer to try to write to printer port 3778. Once again the beeper should sound.

The sequence is repeated five times with the last address, hexadecimal 37E8, being left as the switch setting for all future tests. The master unit is permanently set at address 37F8 for all remaining tests. The test takes whatever time it takes to flip the switches and press a key.

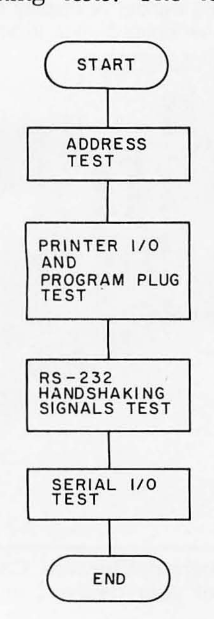


Figure 2: *Flowchart of the four-step sequence employed to test the COMM-80.*

Printer Port and Programming Plug

Figure 3a outlines the hardware necessary to test parallel I/O. On the COMM-80, there is one full 8-bit parallel I/O port for the printer and one 8-bit option-select programming-plug input port. The latter has no physical connection to the serial hardware, but is used to set serial-communication options under software control. With the interface set at hexadecimal 37E8 the programming

Text continued on page 58

Listing 1: *BASIC program testing the address decoding of the COMM-80.*

```
100 PRINT"************  ADDRESS CHECK  **************"
105 REM THIS SUBROUTINE CHECKS EACH ADDRESS BIT OF THE ADDRESS
107 REM SELECTION SWITCH
130 PRINT"SET ALL ADDRESS SWITCHES TO THE OPEN POSITION"
140 GOSUB 510
150 POKE 14328,0
160 GOSUB 500
170 IF A$="@" THEN 180 ELSE 150
180 PRINT:PRINT"CLOSE SW1 ONLY" :GOSUB 510
190 POKE 14200,0
200 GOSUB 500
210 IF A$="@" THEN 220 ELSE 190
220 PRINT:PRINT"CLOSE SW2 ONLY" :GOSUB 510
230 POKE 14264,0
240 GOSUB 500
250 IF A$="@" THEN 260 ELSE 230
260 PRINT:PRINT"CLOSE SW3 ONLY" :GOSUB 510
270 POKE 14296,0
280 GOSUB 500
300 IF A$="@" THEN 310 ELSE 270
310 PRINT:PRINT"CLOSE SW4 ONLY" :GOSUB 510
320 POKE 14312,0
330 GOSUB 500
340 IF A$="@" THEN 350 ELSE 320
350 PRINT:PRINT"ADDRESS TEST CONCLUDED....LEAVE ADDRESS SWITCHES
 IN THIS SETTING";
360 PRINT"FOR REMAINDER OF TESTS AND SHIPPING"
370 GOSUB 2500
380 RETURN
500 A$=INKEY$ :RETURN
510 PRINT"IF YOU HEAR A BEEP THEN PRESS AN @ KEY" :RETURN
2500 PRINT:PRINT:PRINT"PRESS ANY KEY TO CONTINUE TEST"
2510 IF INKEY$<>"" THEN RETURN ELSE 2510
```

Listing 2: *BASIC program testing the printer parallel port and programming plug of the COMM-80.*

```
10 REM COMM-80 DIAGNOSTIC PROGRAM
20 REM
30 REM MASTER UNIT SET FOR ADDRESS F8-FB
40 REM
50 DATA 0,1,2,4,8,16,32,64,128,255
55 FOR X=1 TO 10 :READ Z(X) :NEXT X
1000 PRINT:PRINT:PRINT"*******  PRINTER PORT AND PROGRAMMING PLU
G TEST  *******"
1010 FOR X=0 TO 9
1020 POKE 14312,Z(X) :REM SET DATA ON TEST UNIT PRINTER OUTPUT
1030 S=PEEK(14312)  :REM READ TEST UNIT PRINTER INPUT
1040 S1=INP(233)  :REM READ TEST UNIT PROGRAMMING PLUG
1050 S2=PEEK(14328) :REM READ MASTER UNIT PRINTER INPUT
1060 IF S+S1+S2<>3*Z(X) THEN 1200
1070 NEXT X
1080 PRINT"PROGRAMMING PLUG AND PRINTER PORT CHECK OK"
1090 RETURN
1200 IF S2<>Z(X) THEN PRINT"BAD PRINTER OUTPUT PORT --- FAILED O
N ";Z(X);" DATA VALUE" :GOSUB 2500 :RETURN
1210 IF S1<>Z(X) THEN PRINT"BAD PROGRAMMING PLUG INPUT --- FAILE
D ON ";Z(X);" DATA VALUE" :GOSUB 2500 :RETURN
1220 IF S<>Z(X) THEN PRINT"BAD PRINTER INPUT PORT --- FAILED ON
";Z(X);" DATA VALUE"
1230 GOSUB 2500 :RETURN
2500 PRINT:PRINT:PRINT"PRESS ANY KEY TO CONTINUE TEST"
2510 IF INKEY$<>"" THEN RETURN ELSE 2510
```

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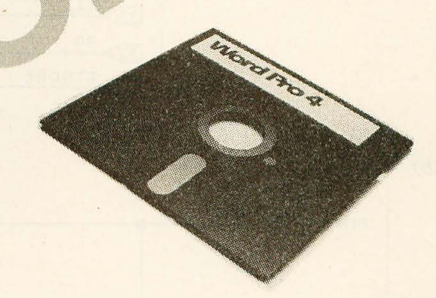
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(3a)

TEST UNIT — PARALLEL I/O TEST CABLE — MASTER UNIT

PRINTER OUTPUT PORT: 3 D0, 5 D1, 7 D2, 9 D3, 11 D4, 13 D5, 15 D6, 17 D7, 34 GND

PRINTER INPUT PORT (master unit): B0 30, B1 32, B2 19, B3 29, B4 28, B5 25, B6 23, B7 21, GND 34

PRINTER INPUT PORT (test unit): 21 B7, 23 B6, 25 B5, 28 B4, 29 B3, 19 B2, 32 B1, 30 B0, 1 STROBE → SEE FIGURE 3b

TO PROGRAMMING PLUG SOCKET ON TEST UNIT

16 PIN DIP HEADER (pins 1–8 connected; pins 9–16 NO CONNECTION)

(3b)

CONNECTIONS FROM IC16

PIN 14 +5V

PIN 1 STROBE

PIN 7 GND

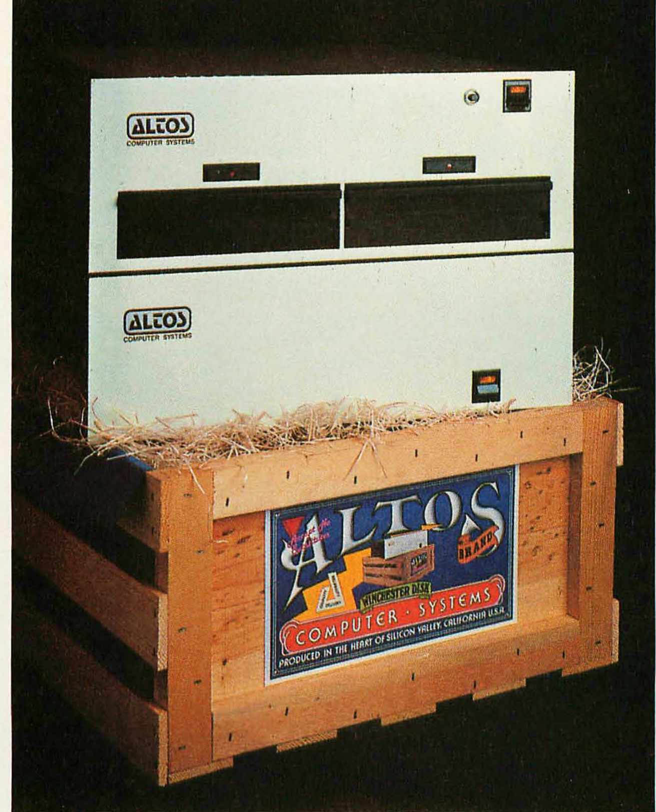
0.1 µF, 3.9K, 10 µF, 1K

74121 0.25 SEC (pins 3 A1, 4 A2, 10 C, 11 R/C, 14, 1 Q̄, 7)

BEEPER

Figure 3: *Hardware for testing the parallel I/O (figure 3a) and addressing (figure 3b) capabilities of the COMM-80. Figure 3a shows an I/O test cable that connects the master and test units. Figure 3b shows a beeper circuit that tests the address selection of the COMM-80.*

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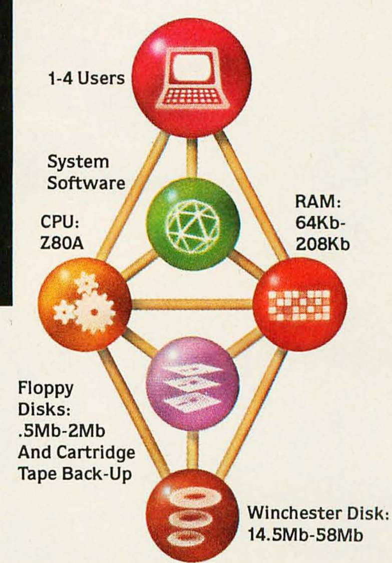
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OUR MESSAGE.

Text continued from page 52:
plug is read as input port hexadecimal E9.

The concept behind this is to have the test unit send a data byte from its own output port to both input ports. The master unit reads the same 8 bits to determine that they are set correctly. While we could have gone from input to output (sixteen wires) between master and test units, nothing better would be accomplished. Figure 5 and listing 2 outline this activity in detail. The test takes about 1 second.

RS-232C Handshaking Test

A similar technique is employed to check the RS-232C handshaking signals. The necessary interface cable is outlined in figure 6. Figure 7 and listing 3 detail the logic flow.

There are two output (DTR, Data Terminal Ready, and RTS, Request To Send) and four handshaking signals (RI, Ring Indicator; CD, Carrier Detect; DSR, Data Set Ready; and CTS, Clear to Send) on the RS-232C interface. Some are almost never used, but all must be checked and functioning. The test is accomplished by tying the input to the output on the test unit and monitoring the output lines again through the master unit. With two signal lines, there are four possible combinations, and all are checked. The test takes about 1 second.

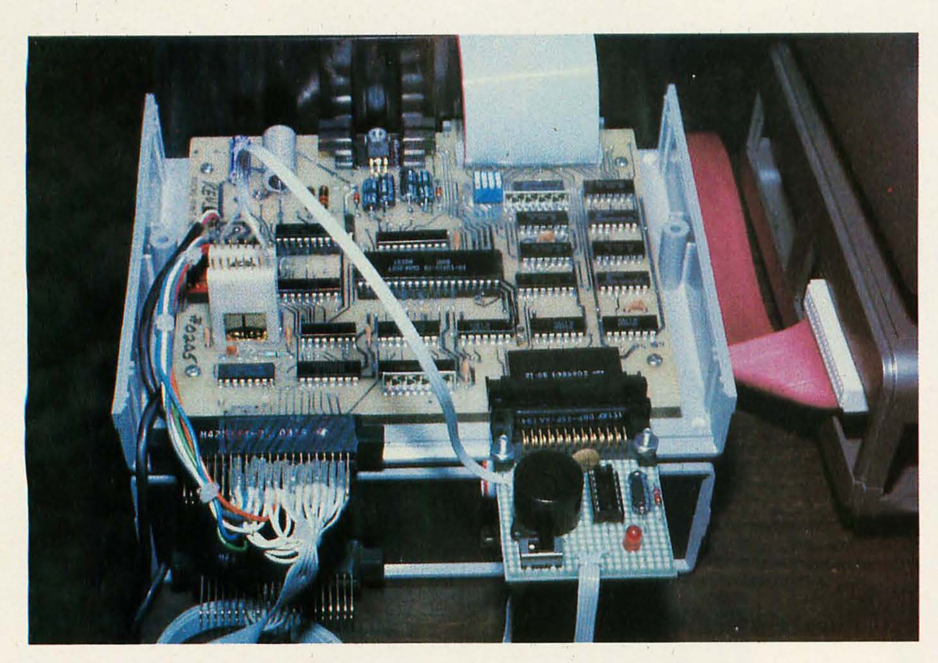


Photo 3: *A production COMM-80 under test with cables attached. A second unit beneath it provides the computer with the necessary I/O capability to successfully interface to both a serial and parallel port. This capability is also available using a Radio Shack Expansion Interface with a RS-232C board installed.*

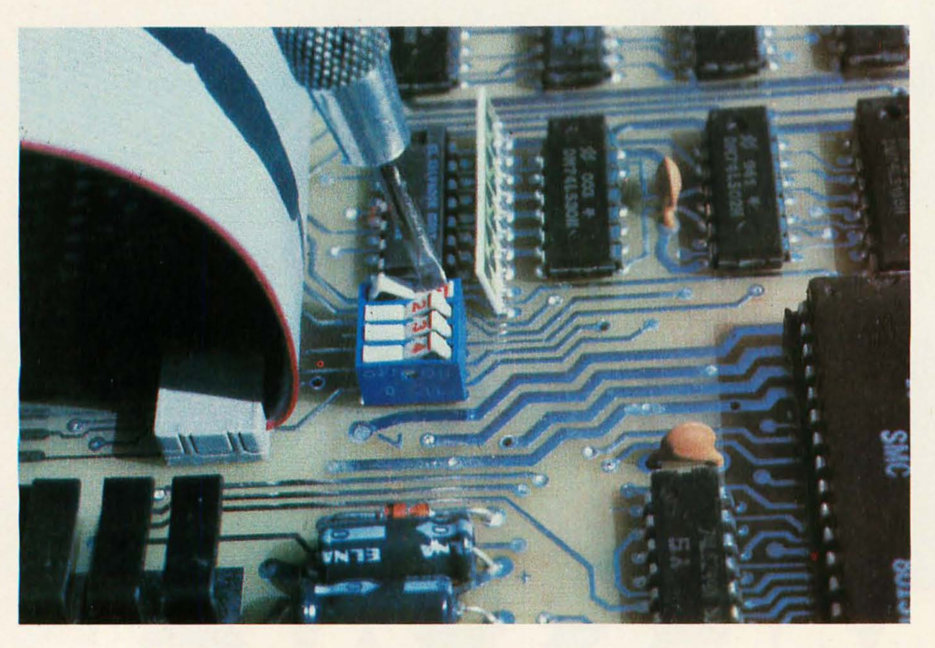


Photo 4: *Address selection during test. When the beeper is heard, the proper address has been selected on the dual-inline plug switch.*

Serial I/O Test

The serial section of the COMM-80 incorporates a COM5016 data-rate generator and a COM2017 UART (universal asynchronous receiver/transmitter). Both are programmable devices. Through them, it is possible to automatically set data rates, parity, word size, and stop-bit options completely through software. This makes testing much easier and eliminates the necessity of manually flipping switches. Figure 8 and listing 4 outline this test.

Upon initial examination, the software looks straightforward. Ten bytes of data (all on, all off, and each individual bit set) are sent from the master unit to the test unit at each of the sixteen data rates. The communication path is then reversed and 10 bytes are sent from the test unit to the master at each data rate to complete the test.

It may be surprising to note that a close examination reveals no assembly-language routine to transmit or receive the serial data. Even at 19,200 bps (bits per second), the serial communication and UART program interaction are accomplished completely in BASIC. (Remember that it takes less time to write a program in the higher-level language. So, if you don't need assembly-language routines, why bother?)

A UART is a hardware device that appears to the computer as a parallel port. To send data, we merely address this port and load 8 bits of data into it. At the conclusion of the output instruction, the UART automatically converts this byte to serial format and transmits it at a rate that is dependent only on the *transmit-clock* input to the UART. If this clock

Text continued on page 64

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5/55	Call
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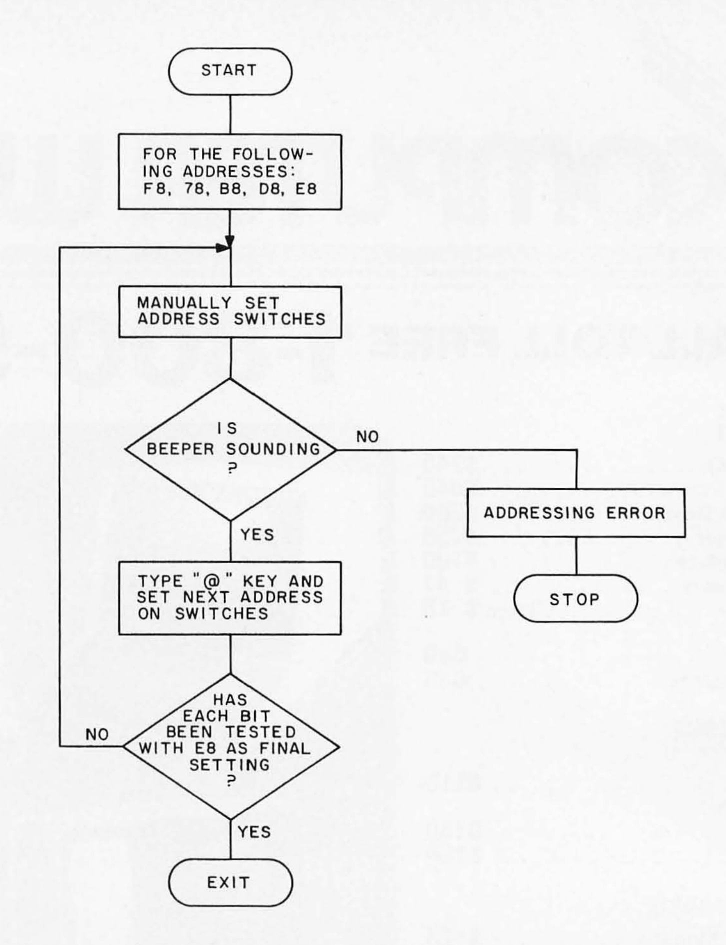


Figure 4: *Flowchart showing the sequence of the address-decoder test program.*

Listing 3: *BASIC program testing the RS-232C handshaking signals of the COMM-80.*

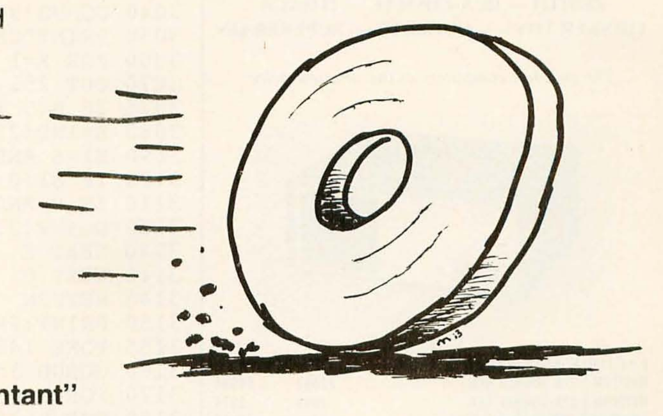
```
60 DATA 0,0,0,2,128,48,1,64,192,3,192,240
65 FOR X=0 TO 3 :READ A(X),B(X),C(X) :NEXT X
2000 REM THIS SUBROUTINE CHECKS THE RS-232 HANDSHAKE LINES
2002 REM THE DTR AND RTS SIGNALS ARE TIED TO RI,CD,DSR, AND CTS
2005 PRINT:PRINT:PRINT"*******  RS-232 HANDSHAKE SIGNAL TEST  **
*****"
2010 POKE 14312,0 :REM SOUND BEEPER
2020 FOR X=0 TO 3
2040 OUT 234,A(X) :REM SET DTR AND RTS ON TEST UNIT
2050 D=INP(248) :D=D AND 192 :REM READ CTS AND DSR ON MASTER
2060 IF D<>B(X) THEN 2200
2070 E=INP(232) :E=E AND 240 :REM READ TEST UNIT LINES
2080 IF E<>C(X) THEN 2300
2090 NEXT X
2100 PRINT"           RS-232 HANDSHAKE SIGNALS CHECK OK"
2110 RETURN
2200 PRINT" MALFUNCTION ON DTR OR RTS OUTPUT SIGNALS" :RETURN
2300 PRINT"MALFUNCTION ON RI,CD,DSR,OR CTS INPUT SIGNALS":RETURN
```

Listing 4: *BASIC program testing the serial input and output of the COMM-80.*

```
50 DATA 0,1,2,4,8,16,32,64,128,255
55 FOR X=1 TO 10 :READ Z(X) :NEXT X
75 DIM N(16)
80 DATA 50,75,110,134.5,150,300,600,1200,1800,2000,2400
85 DATA 3600,4800,7200,9600,19200
90 FOR X=0 TO 15 :READ N(X) :NEXT X
2500 PRINT:PRINT:PRINT"PRESS ANY KEY TO CONTINUE TEST"
2510 IF INKEY$<>"" THEN RETURN ELSE 2510
3000 PRINT:PRINT:PRINT"*******  SERIAL INPUT TEST  *******"
3010 POKE 14312,0 :REM SOUND BEEPER AT START OF TEST
3020 GOSUB 3500
3030 FOR B=0 TO 15
```

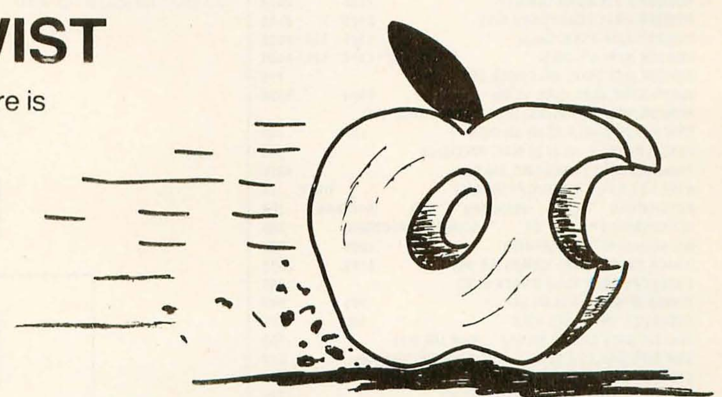
Listing 4 continued on page 62

THEY INVENTED THE WHEEL . . .



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INSOFT CORPORATION
259 Barnett Rd., Unit 2 ▪ Medford, Oregon 97501
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Listing 4 continued:

```
3040 GOSUB 3600
3050 PRINT"CHECKING ";N(B);" BITS PER SECOND"
3060 FOR X=1 TO 10
3070 OUT 251,Z(X) :REM LOAD MASTER UNIT WITH OUTPUT DATA
3075 IF B<5 THEN GOSUB 3950
3080 S=INP(234) :REM READ TEST UNIT STATUS REGISTER
3090 S1=S AND 56 : REM MASK OR,PE, AND FE
3100 IF S1>0 THEN 3800
3110 IF S AND 128=0 THEN 3850
3120 D=INP(235):IF D<>Z(X) THEN 3900
3130 NEXT X
3140 NEXT B
3145 RETURN
3150 PRINT:PRINT:PRINT"********  SERIAL OUTPUT TEST  *******"
3155 POKE 14312,0 :REM SOUND BEEPER AT START OF TEST
3160 GOSUB 3500
3170 FOR B=0 TO 15
3180 GOSUB 3600
```

Listing 4 continued on page 64

START

FOR Z(X) = 0, 1, 2, 4, 8, 16, 32, 64, 128, 255

SET Z(X) VALUE ON TEST-UNIT PRINTER-OUTPUT PORT

IS MASTER-UNIT PRINTER-INPUT PORT = Z(X) ?

NO

PRINT "TEST UNIT PRINTER OUTPUT PORT BAD-FAILED ON DATA BYTE" Z(X)

YES

IS TEST-UNIT PROGRAMMING-PLUG INPUT = Z(X) ?

NO

PRINT "TEST UNIT PROGRAMMING PLUG INPUT PORT BAD-FAILED ON DATA BYTE" Z(X)

YES

IS TEST-UNIT PRINTER-INPUT PORT = Z(X) ?

NO

PRINT "TEST UNIT PRINTER INPUT PORT BAD-FAILED ON DATA BYTE" Z(X)

NEXT Z(X)

YES

IS THIS THE LAST Z(X) VALUE ?

NO

YES

EXIT

Figure 5: *Flowchart showing the sequence of operations of the parallel I/O test program.*

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Listing 4 continued:

```
3190 PRINT"CHECKING  ";N(B);" BITS PER SECOND"
3200 FOR X=1 TO 10
3210 OUT 235,Z(X) :REM LOAD TEST UNIT WITH OUTPUT DATA BYTE
3220 IF B<5 THEN GOSUB 3950
3230 S=INP(250) :REM READ MASTER UNIT STATUS REGISTER
3240 S1=S AND 56 :REM MASK OR,PE, AND FE
3250 IF S1>0 THEN 3800
3260 IF S AND 128=0 THEN 3850
3270 D=INP(251) :IF D<>Z(X) THEN 3900
3280 NEXT X
3290 NEXT B
3300 PRINT:PRINT:PRINT"TEST COMPLETE"
3310 RETURN
3500 OUT 232,0 :OUT248,0 :REM RESET MASTER AND TEST UNITS
3510 OUT 234,228 :OUT 250,228 :REM SET BOTH UNITS FOR 8 BITS,
3520 REM EVEN PARITY AND 1 STOP BIT
3530 RETURN
3600 OUT 233,B+B*16 :OUT 249,B+B*16 :REM SET EQUAL BAUD RATES
3610 RETURN
3800 PRINT"STATUS BIT ERROR":GOSUB 2500 :RETURN
3850 PRINT"NO DATA RECEIVED":GOSUB 2500 :RETURN
3900 PRINT"WRONG DATA RECEIVED":GOSUB 2500 :RETURN
3950 FOR A=0 TO 60 :NEXT A :RETURN
```

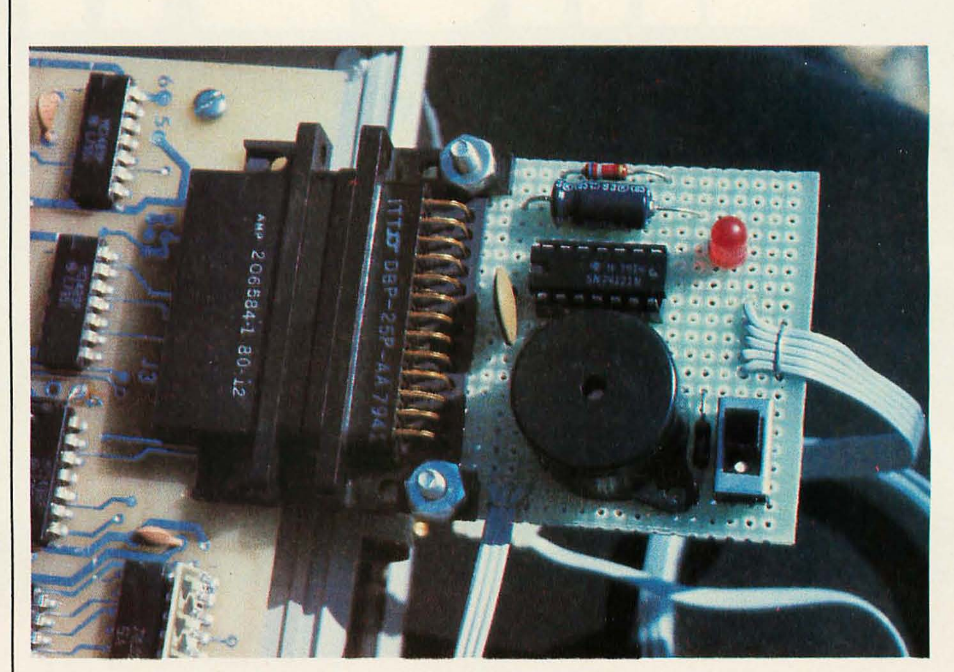


Photo 5: *Close-up of RS-232C connector on the unit under test. The circuit on the perforated board is a 0.25-second monostable multivibrator (one-shot) activating a low-voltage beeper.*

Text continued from page 58:

is 800 Hz, then the information will go out at 50 bps. If, on the other hand, the clock is 153,600 Hz, the information will go out at 9600 bps. The only difference to the programmer is that, at 9600 bps, he can transmit the next byte sooner.

To read the incoming data, the program periodically reads the UART-status register as would be done with any input port and checks to see if the DAV (data available) flag is set. When that occurs, the program reads the data from the UART and resets the DAV line. Similar I/O-port manipulations accomplish error checking and option setting.

This can be done in BASIC just as well as in assembly code—only, not quite as often. We may be able to send data at 19,200 bps, but it can be sent by BASIC only at about 10 *characters* per second. Similarly, we may be able to read data from the UART in BASIC at 19,200 bps, but it also better not come any faster than 10 characters per second.

Since we can control the rate at which we send data, we can easily

Text continued on page 70

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CRT Color: Green P31 phosphor
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Display Format: 25 lines of 80 characters
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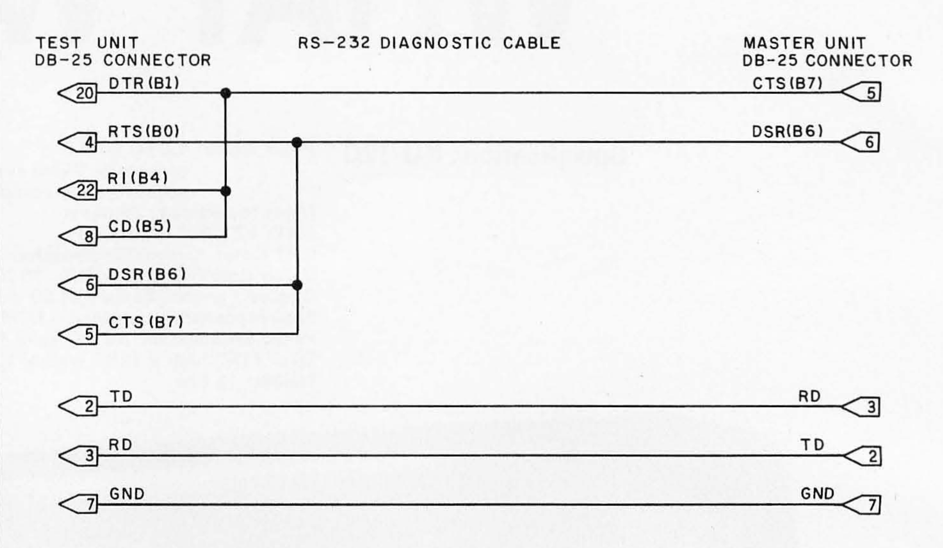


Figure 6: *Schematic diagram of the RS-232C interconnection cable between the master and test units.*

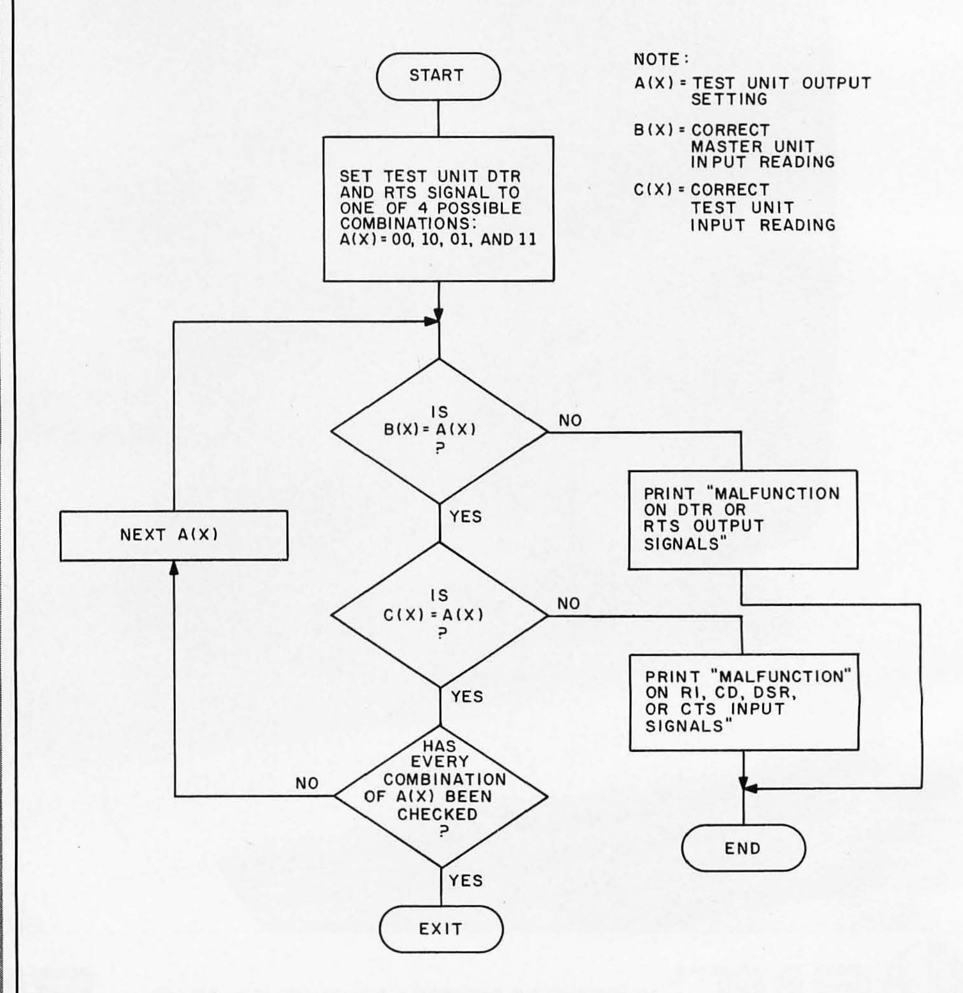


Figure 7: *Flowchart showing the sequence of operations of the RS-232C handshaking test.*

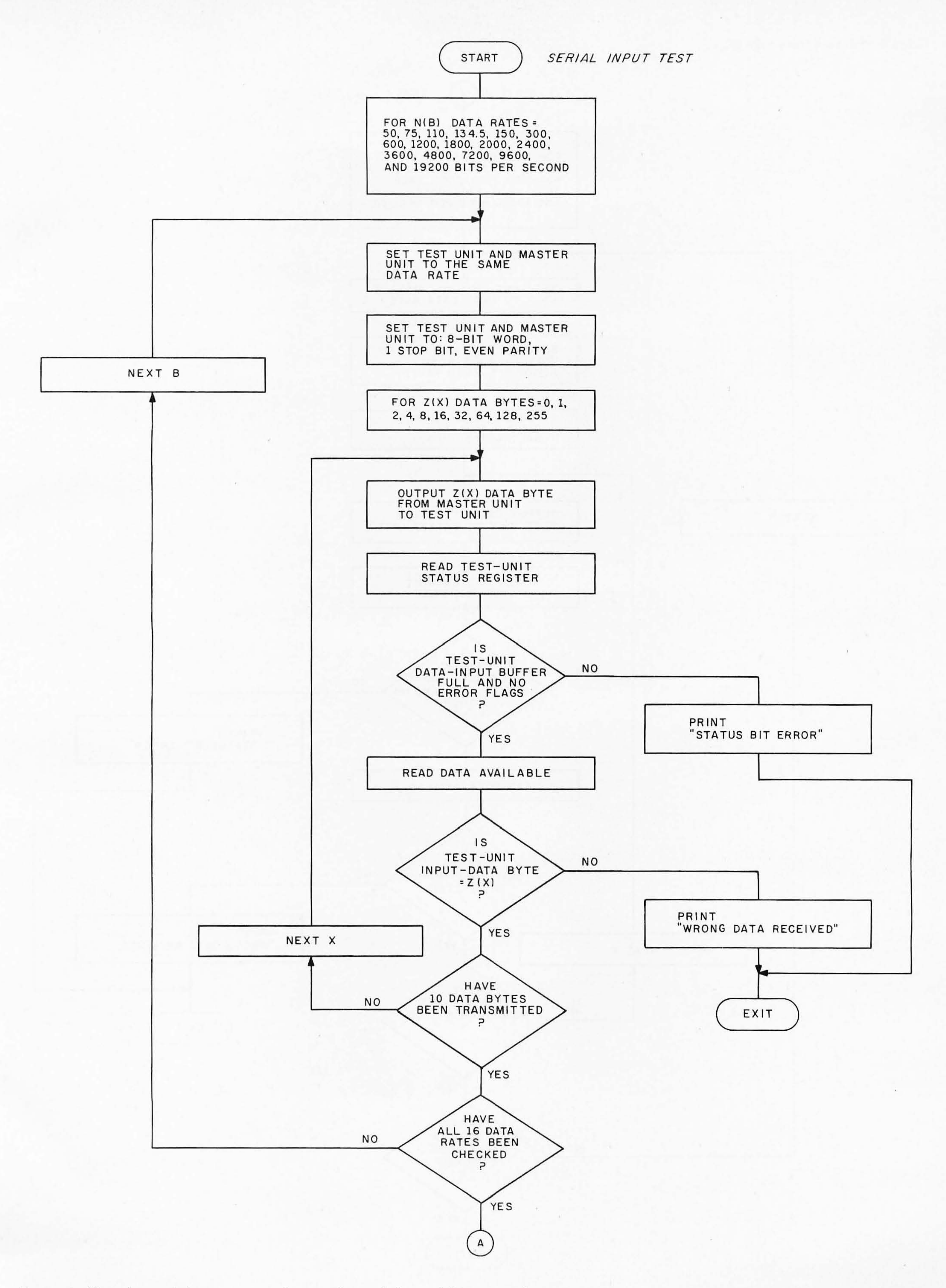
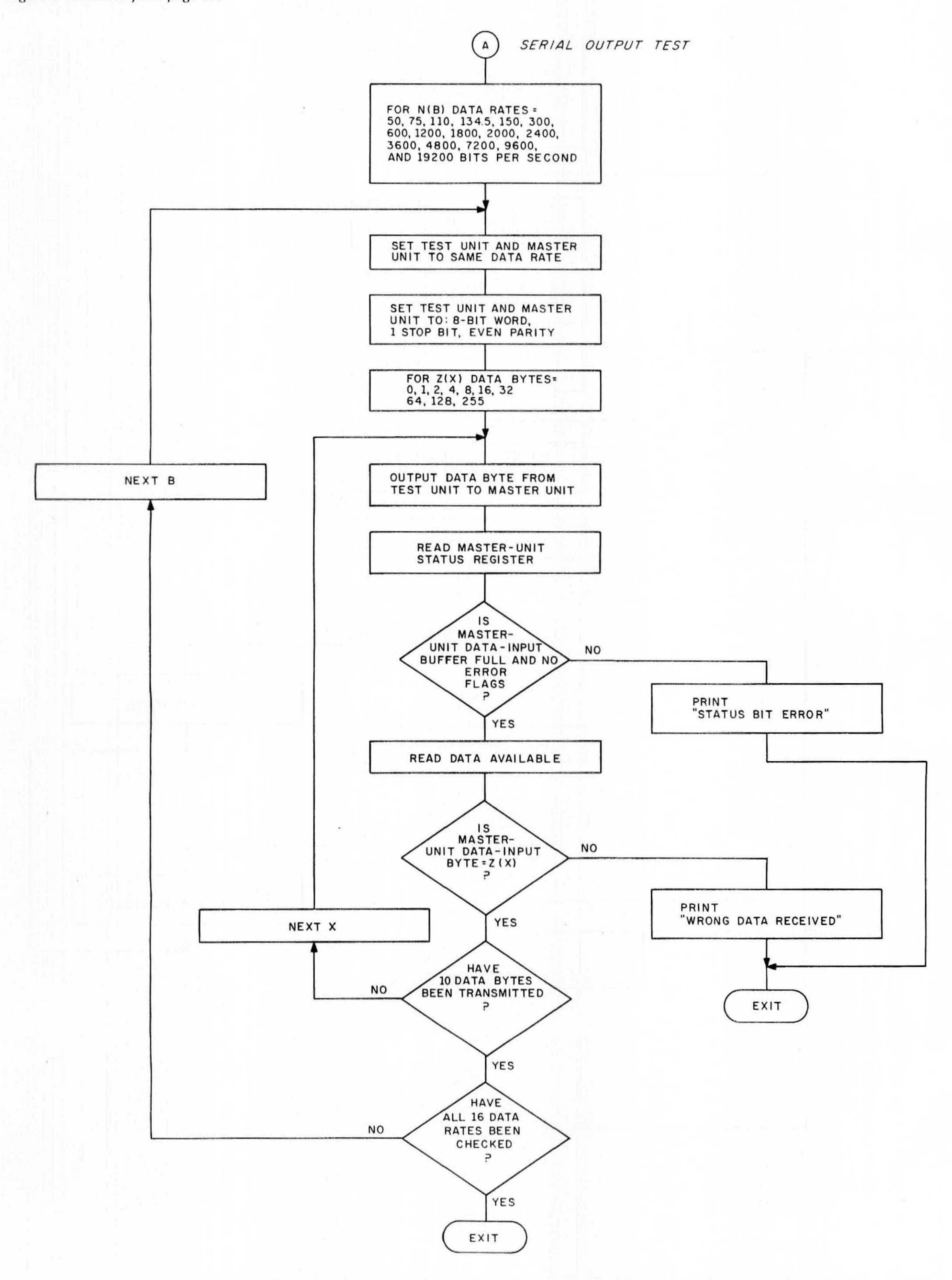


Figure 8: *Flowchart of the sequence of operations of the serial input and output tests.* *Figure 8 continued on page 68*

Figure 8 continued from page 67:



Text continued from page 64:

send it at a rate that can be digested. The UART's function is primarily certified by the conversion/transmission and reception/reconversion process rather than the number of characters it can send through the wires. If it works for 1 character per minute, it will work for 100 characters per second. In truth, though, I decided to settle on 10 bytes which exercise each bit and to send each byte with parity enabled. The entire test, automatically checking thirty-two data rates, takes 39 seconds.

You might ask, as an afterthought, why I didn't just loop the input to the output on the test unit and check it that way, rather than utilizing a separate communications channel. The typical failure on a data-transfer-rate generator is that it sticks at one frequency for a group of data-rate settings. If this malfunctioning clock signal is simultaneously applied to both the transmit and receive sections of the UART under test, the data in and out will still be synchronized and no error will be detected. The only true test is to send data at a known rate from an external source and try to read it.

Conclusion

As you think about this presentation and consider possible applications, keep in mind that there are limitations as well as strengths in any high-level language. First, common sense should tell you that high-level languages suit only smaller applications. BASIC gets bogged down in both programming confusion and execution time as programs get larger than 4 K bytes.

On the other hand, appreciate it as a learning tool for understanding control applications with limited stress on the programmer. BASIC is an excellent language for becoming introduced to man-machine interfacing. A good programmer will not stop there and will soon become interested in more complete languages such as FORTH and tiny-c, which can be expanded to meet the specific problems.

You have to start somehow, and this way is fairly painless.■

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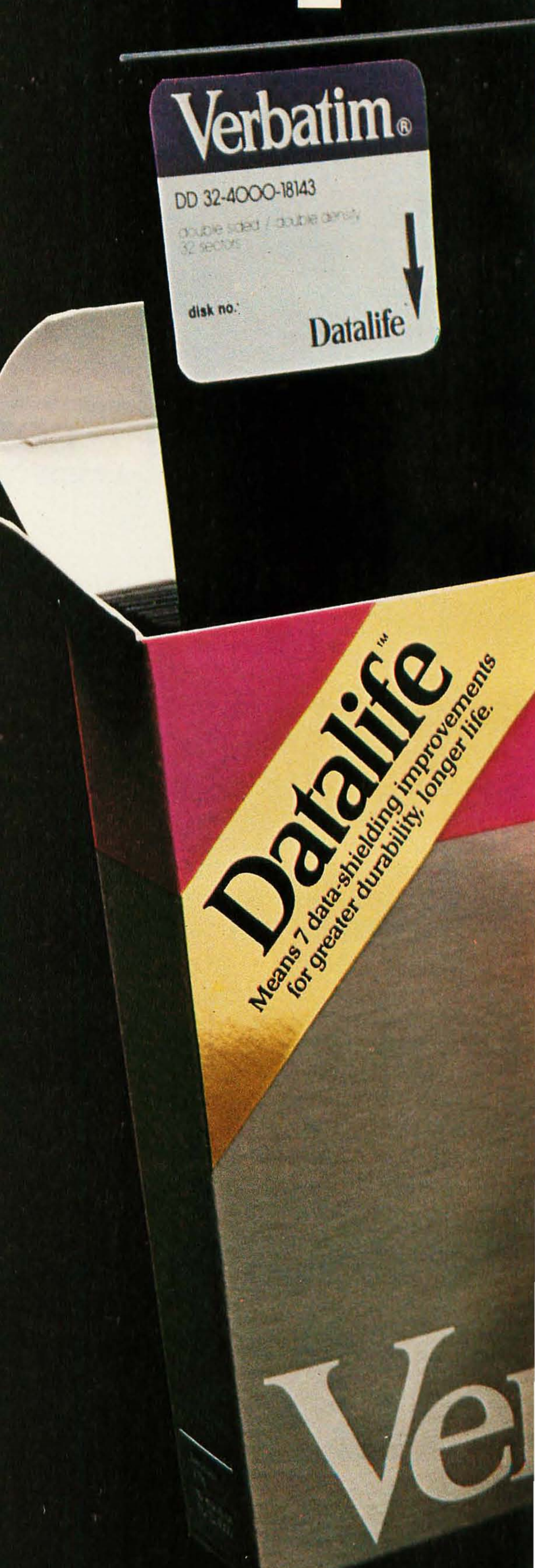
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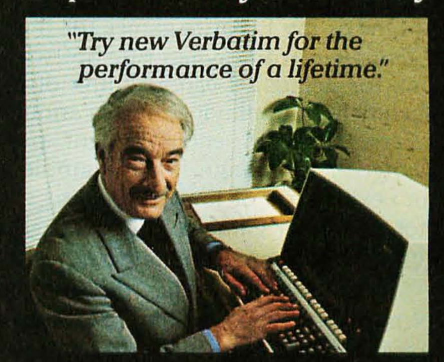
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Dungeon Campaign

Gregg Williams, Editor

One of my favorite games for the Apple II is *Dungeon Campaign*, from Synergistic Software (see "At a Glance" box for details). I cannot think of any game that causes such delight in playing, and I cannot think of a game that offers so much entertainment per unit of program. *Dungeon Campaign* is an example of fine game design and expert use of limited resources. Even though it does not use either game paddles or high-resolution graphics, it is far more entertaining than most games that do.

When the game begins, the computer draws four levels of mazes and erases them (this takes a minute or two). It has just created the maze that you will explore. After the full maze has been created, the program places you in the middle of a blank area that represents the top level of the maze. You use five 1-keystroke commands (U, D, R, L, and J) to move your explorer group (shown as a red square) up, down, right, or left (J for jump can precede any of these commands to jump over a square that might contain danger). As you move in the maze, adjacent walls become visible, allowing you to explore the level you are on. If you are lucky in your explorations, you will find some treasure, your group of explorers will not be totally destroyed, and you will leave the bottom level of the maze, thus winning the game.

The object, of course, is to find treasure; but in your explorations you may find stairways, pit traps, monsters, poison gas, man-eating dragons, and several other inhabitants; I will not tell you about these others to give you the surprise of discovering them. Combat with different kinds of monsters is resolved by die rolls for each side and subsequent computation (all done by the program); this gives the program an entertaining *Dungeons and Dragons*-like flavor.

The program is, at times, subtle. For example, sometimes the bottom level is drawn with the single exit blocked off (the maze is randomly created for each game). At first, I thought there was no way to leave the maze and win the game. But, in a later game, I discovered a "magic carpet" treasure that can be used only once to take your explorers over walls. This is an indication of the sophistication of this seemingly simple (but always enjoyable) game. ■

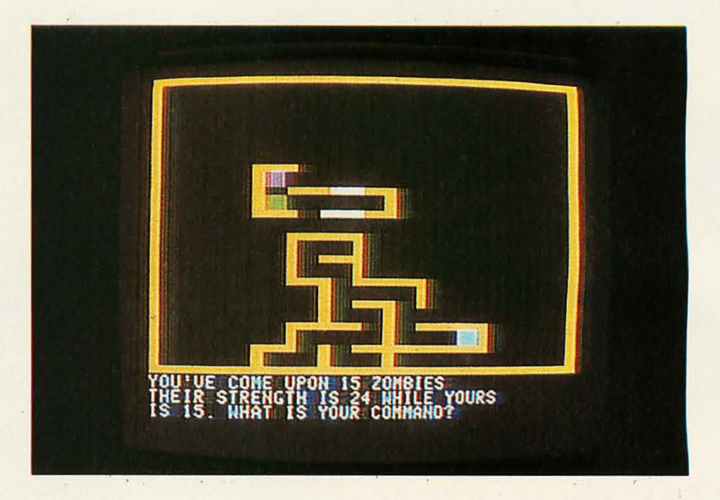


Photo 1: *A partially explored maze in* Dungeon Campaign. *The red and green squares in the middle of the display are the explorers and a group of zombies, respectively, that are about to do battle. The thick white lines denote a stairway, while the light blue square near the bottom represents a hazard of unknown kind (at the moment).*

At a Glance

Name
Dungeon Campaign

Type
Low-resolution color graphics game

Manufacturer
Synergistic Software
5221 120th Ave SE
Bellevue WA 98006
(206) 641-1917

Price
$15 cassette, $17.50 disk

Format
Cassette tape or 5-inch disk

Language
Applesoft and Integer BASIC versions (both versions supplied in each package)

Computer
Apple II or Apple II Plus, with 32 K bytes of memory (16 K bytes for cassette Integer BASIC version)

Documentation
Instruction sheet plus instructions in program

Features
Sound effects through Apple II speaker

Audience
Game enthusiasts of all ages (simple enough for children)

The best news since CP/M... customizable full screen editing

North Star | **Sorcerer**
Heath H8/H89 | **TRS-80 Model I**
Super Brain | **TRS-80 Model II**

Most other CP/M Systems with CRT or Memory Mapped Displays.

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VEDIT is ideally suited to program development and it's special features make it the most valuable development tool a programmer can have. VEDIT appeals to word processing users too. Many simple text editing tasks, such as mailing lists, are faster and easier to do with VEDIT than with more complex word processors.

Features of VEDIT:

Full screen editor with status line and cursor. The screen continuously displays the region of the file being edited. Changes are made by first moving the cursor to the text you wish to change. You can then overtype, insert any amount of new text or hit a function key. These changes are immediately reflected on the screen and become the changes to the file.

Full array of cursor movements with single key movement to begin and end of lines and to tab positions.

Function keys for character delete, line delete and allowing line splitting and concatenating.

Text movement is very easy using a text register.

Flexible command mode allows global search and substitute, repetitive editing operations.

File handling allows files to be merged on input, split on output, drive selection and more. Blocks of text are readily copied from one file to another.

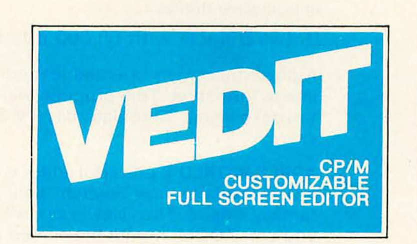
Disk buffering can automatically perform Read/Write for files larger than available main memory.

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A Stellar Trek

Harold Nelson, Editor

You, captain of the starship *Enterprise*, begin your task of freeing the galaxy from the threat of the Klingon Empire and its Romulan allies by selecting the members of your crew. Next you must make some general strategy decisions.

There are two types of encounters (games) to choose from. Regular games are always different, while tournament games have identical outcomes if played in the same way. This is an interesting feature, because most games of this type are either *stochastic* (output from a given input is somewhat random) or *deterministic* (output from a given input is fixed). This feature of choice between these two kinds of games opens many possibilities for developing and practicing strategies, competing against other players, and still not "running out of game" as soon as a game has been successfully completed.

At a Glance

Name
A Stellar Trek

Type
High-resolution color graphics game

Manufacturer
Rainbow Computing Inc
9719 Reseda Blvd
Northridge CA 91324
(213) 349-5560

Price
$24.95

Format
5-inch floppy disk

Language
BASIC

Computer
Apple II with 48 K bytes of memory, with Applesoft floating-point BASIC, and a color display

Documentation
Photocopied, 8½ by 11 inch stapled packet with a table of contents for sections on game operation and descriptions of commands.

Audience
Star Trek fans and others 9 years old and up interested in Adventure-type games

a WORD to the wise...

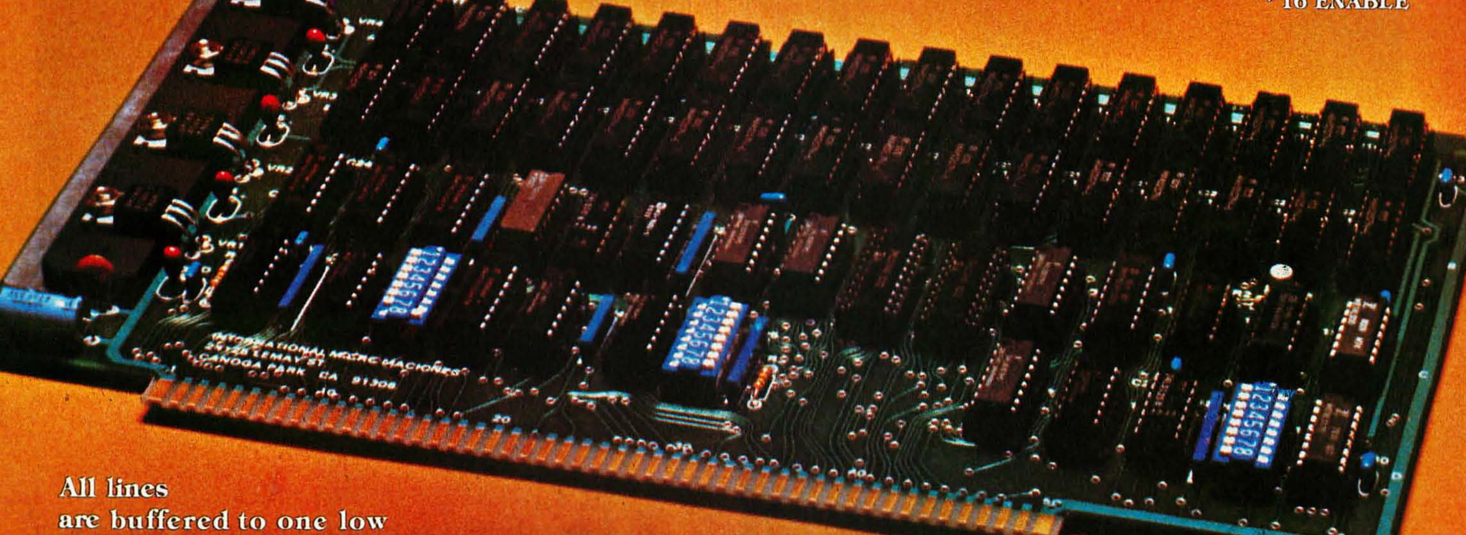


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Photo 1: *The Klingon ship in sector 9 (row), 9 (column) fires on the* Enterprise *in sector 5,2. In addition to the* Enterprise *and three Klingon ships, there are six stars in this quadrant. To the right of the quadrant display is important status information. Below that is a grid giving information on the quadrants surrounding the one currently occupied by the* Enterprise, *with the displayed quadrant in the center. In the space below the display you are given some messages and enter your commands.*

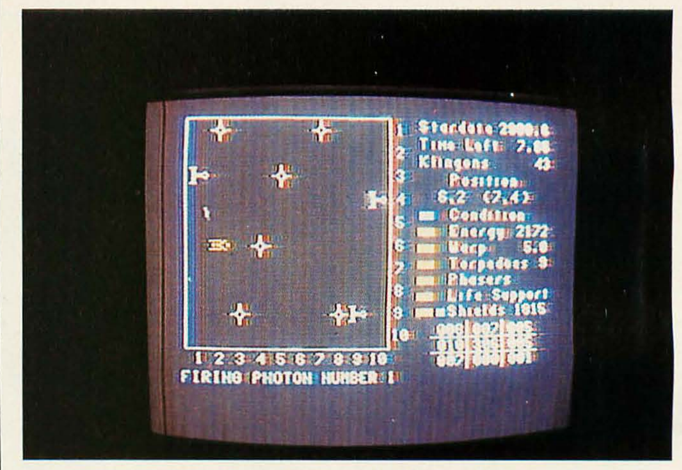


Photo 2: *A photon torpedo from the* Enterprise *is on its way to the Klingon ship in sector 3,1.*

Your next decision is to determine the length of your trek (in stardates, not real time). The longer the game, of course, the more opponents you will have to overcome.

Finally, you will select the level of difficulty for your encounters. The choices range from Novice (quite easy), through Expert (extremely difficult), to Emeritus (perhaps not humanly possible).

Having made your choices, you are ready to begin your mission. From this point on, the format for playing *A Stellar Trek* is basically that of the standard *Star Trek* games. You can move about the galaxy of sixty-four "quadrants" seeking Klingons or visiting starbases for energy and repairs. The Move commands (manual or automatic) require some thought and care in execution, but the documentation explaining their use is quite clear.

When you encounter Klingons or Romulans, you can do battle using either phasers or photon torpedoes. Again, use of these commands requires some care but here, too, the documentation is very good (see box).

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The Micromodem II can also be used with the Bell & Howell computer.

A Stellar Trek also has several interesting commands not present in standard versions of *Star Trek* games. For example, you can scan a nearby planet for dilithium crystals. If they are present, you can beam down to the planet, mine the crystals, and return them to the *Enterprise*. The dilithium crystals can then be used as an emergency source of energy, though they tend to be unstable. You can, if you are desperate enough, employ an experimental death ray. Even if the *Enterprise* is abandoned or destroyed, all is not necessarily lost.

An important feature, since games can take a very long time, is the Freeze command. This enables the player to save the game being played for later completion.

A Stellar Trek makes very fine use of the Apple II high-resolution graphics. (See photos 1 and 2.)

As indicated above, this game is not played in real time. The only annoying aspect of the game, in fact, is the amount of time it takes for displays to change, to enter new commands, and to be able to react to new situations. It also takes an awfully long time for a photon torpedo to find (or miss) its target.

Apart from the fact that this is not a fast-paced game, it is, in all other respects, an excellent version of an old standard. It requires thought, planning, and some luck. It provides engaging enjoyment (or frustration for the unwary). *A Stellar Trek* is a very fine game and makes good use of the capabilities of the computer.■

Note: *The documentation contained in the original package received did not explain all of the options available with the use of the phasers. However, a call to the people at Rainbow Computing Inc resulted in an updated version of the documentation. This new version nicely clarifies all possible uses of the phasers and a few other matters in addition. This immediate action based on our suggestions is very impressive. It seems that this company has a sincere interest in user satisfaction from its software.*

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Call for Papers

The Software Engineering Technical Committee of the IEEE Computer Society is soliciting papers for the Software Engineering Standards Applications Workshop on August 18 thru 20, 1981, in San Francisco, California. Suggested topics include the selling of standards, process standardization versus product standardization, unrealizable standards, standards enforcement, factors in standards selection and tailoring, effectiveness of standards and the case against standards.

Five copies of presentation proposals are requested; they should consist of a 750-word summary. Final papers should be approximately 3000 words. Mail proposals by January 26, 1981. Acceptance notification and author kits will be sent by March 30, 1981. Send proposals to E Bersoff, CTEC Inc, 7777 Leesburg Pike, Falls Church VA 22043. For additional information, contact Robert M Poston, EAI, 185 Monmouth Pky, West Long Branch NJ 07764, (201) 229-1100.■



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Product Review

Morloc's Tower

Gregg Williams, Editor

The Automated Simulations' Dunjonquest games are as close to a computer-automated *Dungeons and Dragons*-type dungeon as I have seen. Naturally such games do not have the inventiveness or the vindictiveness of a human dungeonmaster. They do have the advantage of allowing you solitary play. And, in contrast to conventional Adventures which are essentially puzzles that, once solved, hold no interest, the Dunjonquest games are randomly configured at startup to give you a worthwhile game even if you have won the game before.

Morloc's Tower is a Dunjonquest of average complexity, simpler than *The Temple of Apshai*, yet more complicated than the beginner's *Datestones of Ryn*. Your character is Brian Hammerhand, and his self-imposed task is to kill Morloc the Mad before sunrise to prevent the destruction of Hagedorn, a village under Morloc's rule. The format of the game is simple: the screen shows an overhead outline of the room you (ie: Brian) currently are in (see photo 1). Your character, a small graphics figure in the center of the room, can be caused to move, fight, search, and perform other tasks by an appropriate 1- or 2-keystroke command. There are thirty rooms in the Tower, six levels of five rooms each, and they are drawn for you as you enter them through doors (secret and visible) and stairwells.

At a Glance

Name
Morloc's Tower

Type
Graphic role-playing Adventure game

Manufacturer
Automated Simulations Inc
1988 Leghorn St
Mountain View CA 94043
(415) 964-8021

Price
$14.95

Format
Cassette (also available on floppy disk)

Language
BASIC

Computer
Radio Shack TRS-80 (plus versions for Apple II and Commodore PET)

Documentation
Sixteen-page booklet, 5½ by 8½ inches (14 by 21.5 cm)

Audience
Game enthusiasts (10 years or older)

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The game is similar to conventional Adventures in that there are several treasures in the Tower, some of which are necessary to kill Morloc, others of which will hinder or harm you in the attempt. And, of course, there are monsters that will try to kill you. As an example of commands in *Morloc's Tower*, fighting commands are A (attack), T (thrust), P (parry), F (fire a normal arrow), and M (fire a magic arrow). Each command has different effects on you and your attacker, usually trading off effectiveness of attack or defense with the degree of fatigue or wounds suffered by you. The game takes place in real time, which means you have to act quickly in fights. This makes the game a lot more interesting than most Adventures.

This game, like other role-playing games, takes a lot of time to play, and *Morloc's Tower* must be played at one sitting; there are no commands to save the state of the game. The version that I used, a cassette version for the TRS-80 Model I, is contained on both sides of the cassette. Side one is the program itself, while side two contains three sets of data statements, one of which is read to create a game in one of three levels of complexity. (I found that you *have to* leave the remote jack in the TRS-80 cassette recorder during loading; the program doesn't have enough time to "digest" the data if the tape runs uninterrupted.)

My only complaint against the game is one of speed; character movement is just a bit slow, and the delay of over a minute to redraw a fully explored level (when returning to it from another level) is quite annoying. Both these problems could be solved with a machine-language version of the game. This is the route that all the major Adventure writers (Scott Adams and Greg Hassett, in particular) have taken to improve the quality of their games. ■

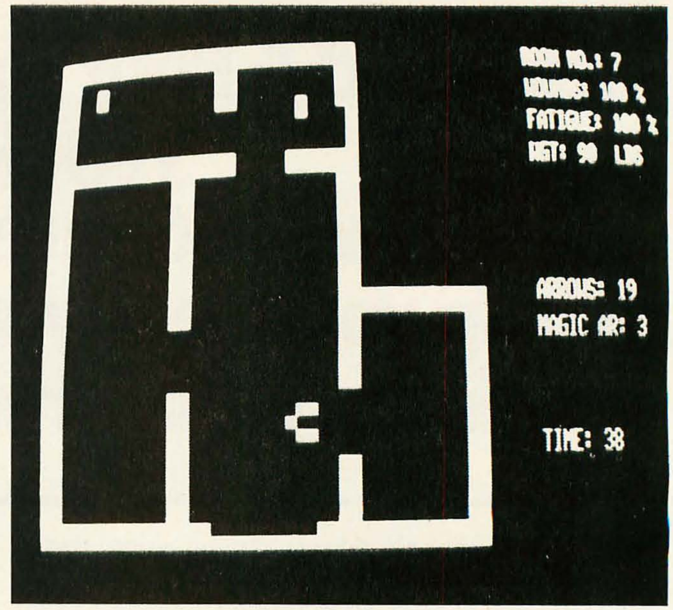


Photo 1: *A game of* Morloc's Tower *in progress on the Radio Shack TRS-80. The three-block symbol near the bottom of the center room represents the player's character, and the two small rectangles are treasures. Information on the status of the game and the player is given on the right-hand side of the screen.*


IN CONTROL

Odyssey: The Compleat Apventure

Harold Nelson, Editor

One Friday afternoon recently, I decided to try my hand at a new game that sounded most intriguing. The evening before I had read over the game documentation pamphlet (I would urge any *Odyssey* adventurer to do the same before undertaking a game). On this particular Friday, I played one game which ended in less than success. A friend then joined me and we played a game together—one person at the keyboard and the other going through the documentation pamphlet. We must have begun this game around 4:30 PM. After thoroughly touring the island on which the game begins (see photo 1) and amassing a large army, a good deal of wealth, and considerable equipment, we decided to embark on a ship we had just purchased (very reasonably priced) for another island. Thinking it was about 6:30 PM, we decided to have something to eat before going to sea. We were astonished to discover that it was actually about 8:00 PM. We had been playing for nearly four hours, though it seemed like only half that time.

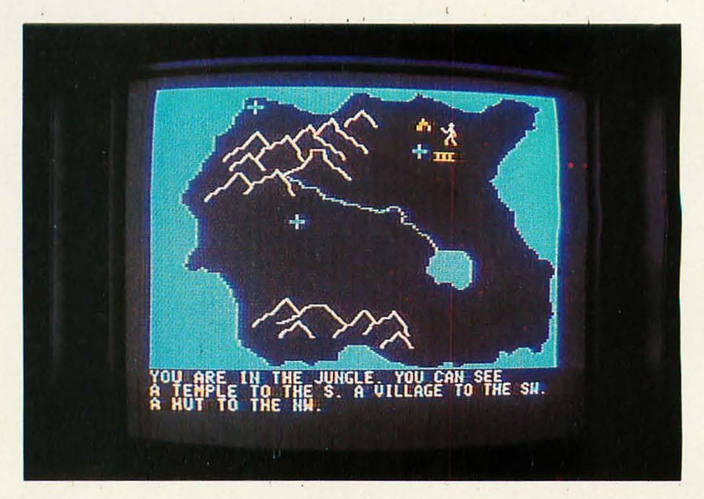


Photo 1: *The island on which the* Odyssey *game begins. The crosses indicate villages containing markets where you can purchase supplies and equipment for your journey. The human shape shows the location of you and your followers (mostly mercenaries). The figure to your south is an ancient temple which is locked and can be opened and entered only with the appropriate devices. The figure to the northwest of you is a hut which is the dwelling of any one of an assortment of characters. Directions, hints, and questions are generally given below the map. Commands are, for the most part, single keystrokes (eg: E to move east). The major exception is typing numbers (eg: amounts of quadroons to bargain for a purchase or a bribe). Photo by Charles Freiberg.*

At a Glance

Name
Odyssey: The Compleat Apventure

Type
High-resolution color graphics game

Manufacturer
Synergistic Software
5221 120th Ave SE
Bellevue WA 98006
(206) 641-1917

Price
$30

Format
5-inch floppy disk

Language
BASIC

Computer
Apple II with 48 K bytes of memory and Integer BASIC

Documentation
Sixteen-page 5½ by 8½ inch (14 by 22 cm) staple-bound pamphlet including a table of contents listing the various aspects of the game. Some directions, hints and questions are included in the program.

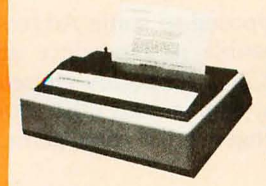
Audience
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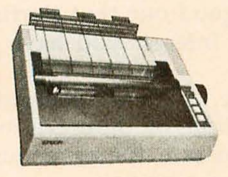


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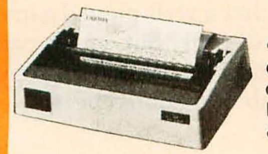
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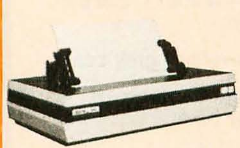
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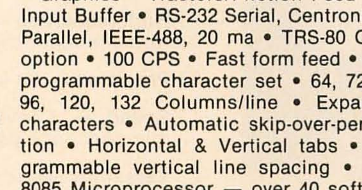
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Obviously, we decided, this is a game worthy of high praise. There is only one warning for the prospective player. The warning is simple: make sure you have sufficient time. It is obviously an engrossing game. It might be advisable to keep a clock handy or even set an alarm to your desired quitting time. Since a game in progress can be saved on any initialized disk and completed later, it is probably better to break off a game than risk the loss of family or job.

Upon returning to our game on that Friday evening, we set sail and were just getting the knack of handling our ship when we were lost in a fog bank and ran aground. We spent quite awhile trying, unsuccessfully, to get free. When we first went aground there was a brief message to the effect that local fishermen would help us for a price. This message appeared quite briefly and did not reappear.

In a case such as this, if the correct command is not found, it may seem as though there is a bug in the program causing it to go into a infinite loop. A call to Synergistic Software convinced us that this is not the case and that there is one command that can result in freeing a ship caught in this situation. (Hint: Use quadroons.)

Some friends have said that they would like to see a little more detail in the documentation about how the outcome of battles with bandits and various monsters is determined. But, on the other hand, the element of uncertainty and chance that the user experiences may add to the excitement and enjoyment of the game. Also, the documentation does include the relative worth of the different offensive and defensive devices available. And, with some luck, one can increase his ability to avoid battle when its outcome appears doubtful.

The finest feature of this game is its use of high-resolution color graphics. It is the best use of color graphics in a game for the Apple that I have seen.

While this program does not operate in real time, certain features of the game give the user the illusion that it is doing just that. This is especially true of traveling on horseback, flying on a magic rug (should you encounter a wizard inclined to give you one), and sailing.

Another strong feature of the game is the great number of possible encounters both on land and at sea and the variety of outcomes that can result from these encounters. These are too numerous to list or begin to describe in a brief review, and learning to deal with them is a major part of the enjoyment of this game.

It is also interesting that, as opposed to some Adventure games, it is virtually impossible to reproduce an *Odyssey* game. Each game starts at a randomly chosen point and the locations of castles, tombs, and other objects and creatures are also changed with each game. Hence, each game is unique.

Conclusions

- This is a very fine game for the Apple II computer. It makes excellent use of color graphics. Fans of Adventure and Dungeon games should find this to be an interesting and challenging addition, with some new twists, to their collections. For those just developing an interest in this type of game, *Odyssey* is such a good one that starting with it may greatly diminish the interest you have in other Adventure games.
- The documentation seems, at the very least, adequate. Some users may desire more detail on how various aspects of the program work. At any rate, there is enough information, presented in a clear and interesting manner, to allow virtually anyone to start playing the game.
- My only criticism of the program is that some of the messages offering hints on what to do next (such as that mentioned above about the local fishermen) appear so briefly that if their meaning is not clear at first or if you are momentarily distracted, they might as well not have been there at all.
- It is important to keep in mind that a well-played game of *Odyssey* is going to take a lot of time, but games can be saved and played in installments. The only short game is an unsuccessful game with an obvious outcome.■

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The Twelve Computerized Days of Christmas

Teri Li and Elizabeth Cooper, POB 481, Peterborough NH 03458

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A glitch on the video screen.

On the second day of Christmas, my computer gave to me
Two keyboard bounces,
And a glitch on the video screen.

On the third day of Christmas, my computer gave to me
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the fourth day of Christmas, my computer gave to me
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the fifth day of Christmas, my computer gave to me
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the sixth day of Christmas, my computer gave to me
Six I/O spasms,
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the seventh day of Christmas, my computer gave to me
Seven system resets,
Six I/O spasms,
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

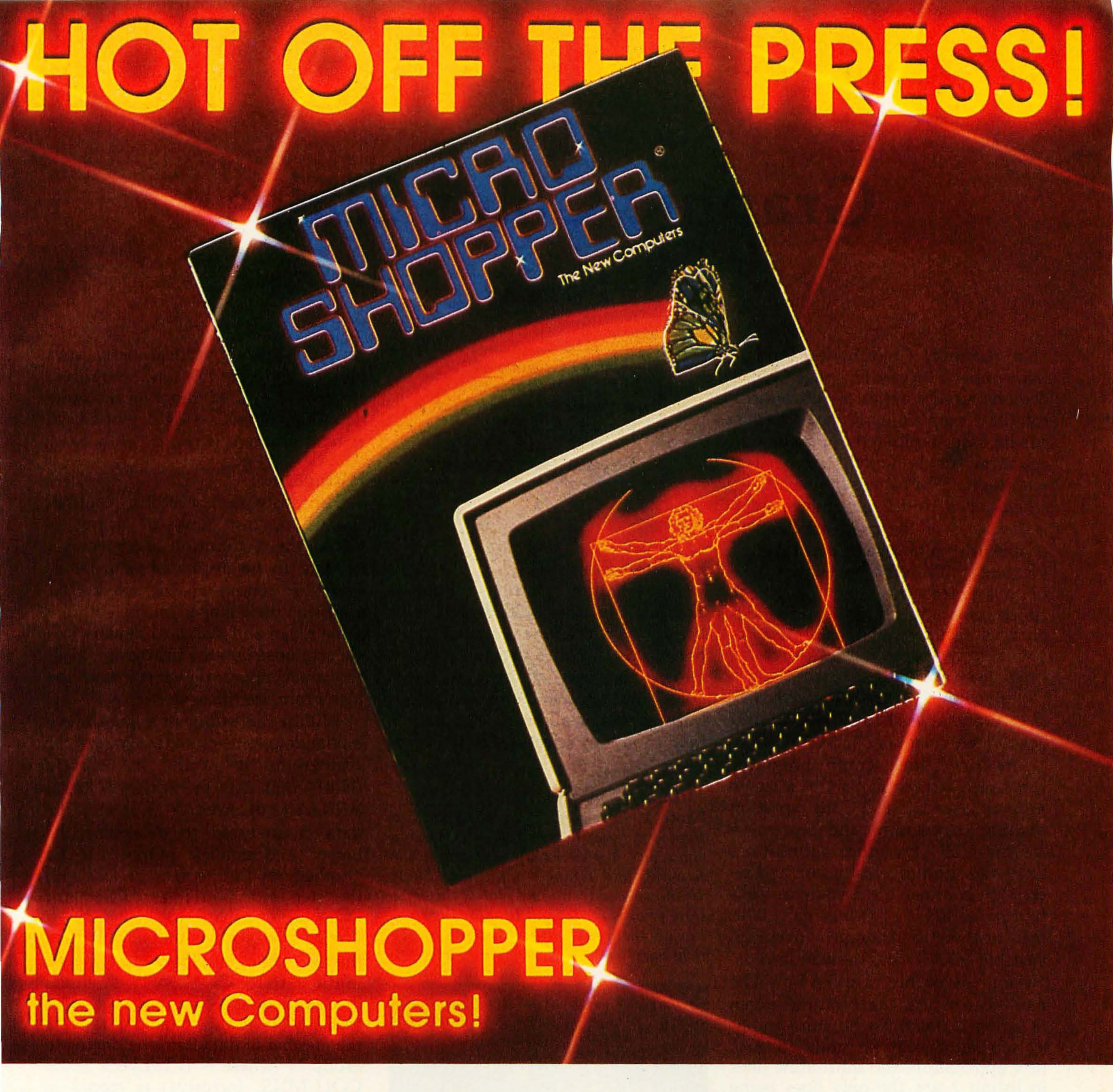
On the eighth day of Christmas, my computer gave to me
Eight worthless printouts,
Seven system resets,
Six I/O spasms,
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the ninth day of Christmas, my computer gave to me
Nine burnt-out fuses,
Eight worthless printouts,
Seven system resets,
Six I/O spasms,
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the tenth day of Christmas, my computer gave to me
Ten disk-drive lockouts,
Nine burnt-out fuses,
Eight worthless printouts,
Seven system resets,
Six I/O spasms,
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the eleventh day of Christmas, my computer gave to me
Eleven damaged diskettes,
Ten disk-drive lockouts,
Nine burnt-out fuses,
Eight worthless printouts,
Seven system resets,
Six I/O spasms,
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the twelfth day of Christmas, my computer gave to me
Twelve blown-out circuits,
Eleven damaged diskettes,
Ten disk-drive lockouts,
Nine burnt-out fuses,
Eight worthless printouts,
Seven system resets,
Six I/O spasms,
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.■



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Graphic Color Slides

Part 2

Alan W Grogono MD
Associate Professor
State University of New York
Upstate Medical Center
750 E Adams St
Syracuse NY 13210

In "Graphic Color Slides, Part 1" (November 1980 BYTE, page 126), I demonstrated a series of subroutines for the Compucolor II that together can be used to plot a set of points, an equation, or horizontal or vertical bar graphs. The listings in this article, when added to the subroutines given in listing 1 of the cited article, will enable us to plot several new types of graphs. These listings also demonstrate the use of these subroutines in building special-purpose programs that generate a desired kind of graph. The programs listed here are designed to run on a Compucolor II with extended disk BASIC and at least 16 K bytes of programmable memory.

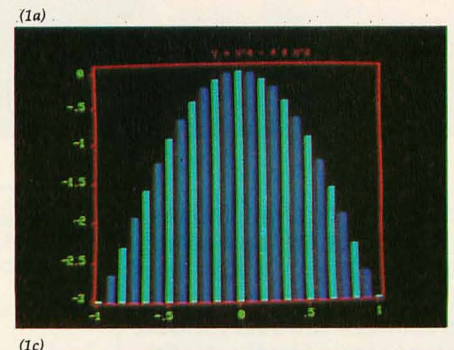
The first three graph programs have been written as part of a single program (see listing 1); the equation plotting, histogram, and regression routines all use the subroutines unaltered. Both the histogram and regression routines use a statistics subroutine at line 11400 that calculates the arithmetic average (program variable MEAN) and the standard deviation (variable DEVIAT). The monthly analysis chart routine, given in listing 2, illustrates how the graphics subroutines can be modified for a new application; the subroutine lines in listing 2 are the only lines being changed, not the entire subroutine. As before, the variable names used in these listings have been chosen to describe their function.

Equation Plotting

The equation plotting routine is contained in lines 1000 thru 1086 of listing 1. This routine is similar to the one in last month's article in that it allows the user to change screen colors and to save a finished graph; but this routine allows you to graph a new equation, select a different type of plot (line or vertical bars), and choose different X- and Y-ranges. Photos 1a thru 1d illustrate the same equation, $Y=X^4-4X^2$, plotted in several different ways.

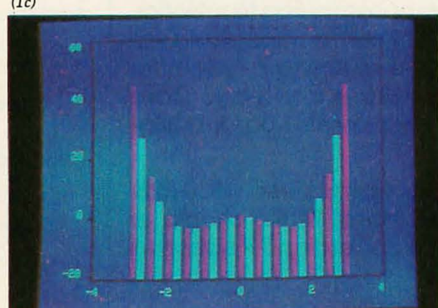
Photo 1: *Examples of equation plotting. Photos number 1a thru 1d show the same equation, $Y=X^4-4X^2$, plotted in different X- and Y-ranges and colors. Photo 1b shows a conventional plot of the equation; photos 1a, 1c, and 1d show the equation as the upper edge of a series of vertical bars.*

(1a)

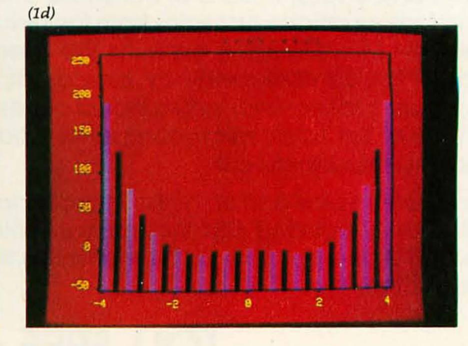


(1b)

(1c)



(1d)



Histogram

The histogram plotting routine, lines 2000 thru 2390 in listing 1, allows the distribution of a given set of data to be displayed as a histogram. In addition, the theoretical Gaussian (bell-shaped) curve with the same mean and standard deviation is superimposed on the histogram; also, the areas under the curve and the histogram are the same.

Within the listing, the one-dimensional data to be plotted as part of the histogram is stored in ARRAY (N,0)—that is, in ARRAY (1,0), ARRAY (2,0), ARRAY (3,0), etc. The data is analyzed to determine the largest and smallest numbers to be graphed on the horizontal axis and the step size (variables HIGH (0), LOW (0), and JUMP (0), repectively). The user selects the number of bars in the histogram, and the value is stored in the variable COLUMNS. The data is classified as belonging to one of COLUMNS groups, and the tally of the number of data items belonging to group N (where N is between 1 and COLUMNS, inclusive) is stored in ARRAY N,1). The height of the equivalent Gaussian curve is calculated in the statistical subroutine at line 11400, leading to the display of

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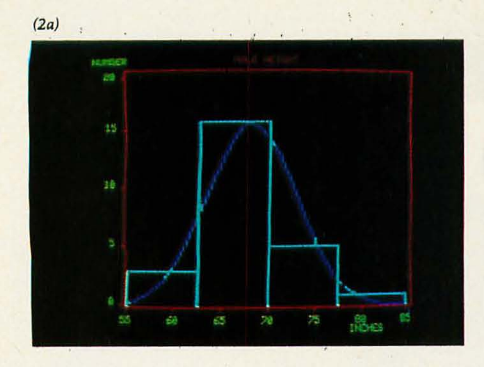
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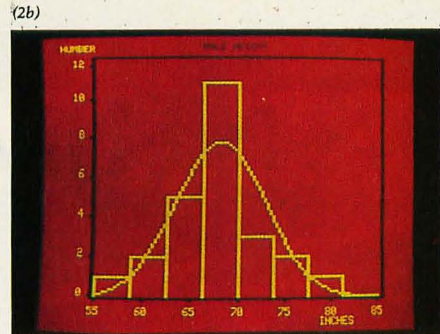
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(2a)



(2b)



(2c)

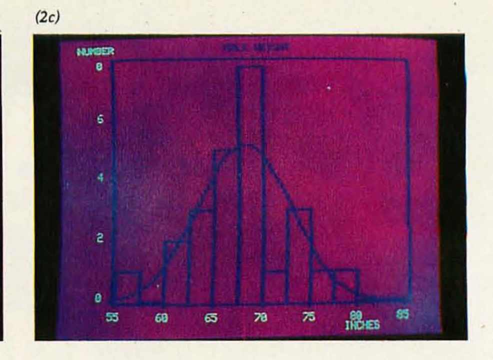


Photo 2: *Examples of histograms. Here, a Gaussian (bell-shaped) curve having the same mean and area is superimposed on each of the histograms. Both the number of bars in the histogram as well as the colors used can be chosen by the user.*

the histogram and Gaussian curve with labeled X- and Y-axes.

The same data, once entered, can be displayed with different colors and a different number of histogram bars. Photos 2a thru 2c show the same set of data displayed in different ways.

Regression

The regression routine, lines 4000 thru 4760 of listing 1, allows two sets of data to be plotted with a regression line for comparison. The two sets of data are graphed as X,Y pairs (with the X data being the independent variable and the Y data the dependent variable). Then the computer finds the best line that describes a certain presumed relationship (linear, logarithmic, exponential, or reciprocal, as chosen by the user) for those points. If the chosen relationship is linear (if the user is performing a linear regression), the actual Y value is plotted with its given X value. If the relationship is logarithmic, exponential, or reciprocal, the dependent (Y) variable is replaced by the appropriate transformed value—that is, the X data point is plotted opposite ln Y, e^Y, or 1/Y, respectively.

After the data pairs and the regression type have been entered, the original Y data (stored in ARRAY [N,2]) is transformed according to the regression type, with the transformed Y values stored in ARRAY (N,1). At this point, the program makes the necessary calculations and displays the resulting graph, plotting the data points and the regression line that best fits them. (Actually, the regression line given by any regression except linear regression is not a straight line but rather a logarithmic, exponential, or reciprocal curve that best fits the data. These curves appear as straight lines because we are graphing X not against Y, but against a transform function of Y—ln Y, e^Y, or 1/Y, respectively.)

Once the data has been entered, it can be displayed in different colors with different kinds of regression. Photos 3a thru 3d show the same data graphed varying the colors and regression type. The data was taken from the following example: we have four test tubes (2, 3, 4, and 6) from a larger series of test tubes, and each one has a chemical solution in it; the independent (X) variable is the tube number, and the dependent (Y) variable is the measured strength of the solution in that tube. A linear regression on these data points (photo 3a) provides a poor fit, as does exponential regression (photo 3b). Logarithmic regression provides a better fit (photo 3c), but reciprocal regression provides the best fit of all (photo 3d).

Monthly Analysis Graph

The monthly analysis graph, shown in photos 4a and 4b, is a specific case of a graph that will plot the values of one or more variables over a given range of the independent variable. Here, income for 4 years is plotted for each month of the year. The

Text continued on page 110

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Listing 1: *Menu-driven program to produce equation plots, histograms, or regression graphs. In order to run correctly, this program needs the subroutines from listing 1 of Part 1 of this article added to it.*

```
5 REM KY 5 REM      GRAPHS.  (C)  A. W. GROGONO.  AUGUST 1979
6 REM     HISTOGRAM, REGRESSION, EQUATION, V1
40 RESTORE :CLEAR 200:DIM I$(12)
50 DATA 1,2,6,4:FOR I= 1TO 4:READ COLOUR(I):NEXT I
90 PLOT 29,27,24,15,14,2,255,6,1,12,3,16,3:REM CLEAR PAGE
100 PRINT "S P E C I A L   G R A P H S":PRINT
110 PRINT :PRINT ,,"1.  CREATE HISTOGRAM"
120 PRINT :PRINT ,,"2.  LINEAR REGRESSION"
130 PRINT :PRINT ,,"3.  PLOT EQUATION"
140 PRINT :PRINT ,,"4.  ERASE/REVIEW IMAGES"
150 PRINT :PRINT ,,"5.  MAIN MENU"
190 PLOT 10,10,9,9,9,9:INPUT "ENTER #: ";CHOICE
200 ON CHOICEGOSUB 2000,4000,1000,7000,220:GOTO 5
220 LOAD "MENU":RUN
490 REM WRITE EQUATION AT 500, EG: 500 Y= X^2 - 3* X
510 RETURN
990 REM
991 REM
992 REM   SUBROUTINE TO PLOT EQUATION
993 REM
1000 DIM ARRAY(25,1):REM PLOT EQUATION
1010 TITLE$= ""
1020 GOSUB 10100:REM EQUATION SUB
1030 PRINT :PRINT ,,:INPUT "X-BARS OR LINE: ";I$
1035 K= 1- (I$= "X")
1040 GOSUB 9000:ON KGOSUB 11100,11200:GOSUB 11900
1042 GOSUB 11800:IF K$= "C"THEN 1040:REM COLOR SELECT
1045 PLOT 3,0,31,6,4,11,3,15,31
1050 INPUT "NEW EQUATION, RANGE, SAVE OR MENU: ";I$
1060 IF I$= "E"THEN PLOT 12:GOTO 10132
1070 IF I$= "R"THEN 1020
1075 IF I$= "S"THEN GOSUB 11500
1085 IF I$= "M"THEN RETURN
1086 GOTO 1045
1190 REM
1191 REM
1192 REM   SUBROUTINE TO ANALYSE DATA AND PLOT HISTOGRAM
1193 REM
2000 GOSUB 10000:REM HISTOGRAM
2010 AXIS= 0:GOSUB 10210:GOSUB 10310
2015 IF HIGH(0)> BIG(0)THEN 2020
2017 BIG(0)= BIG(0)+ JUMP(0)/ 2:GOSUB 10310
2020 PLOT 6,6,12,3,8,5:PRINT "THE HISTOGRAM WILL EXTEND FROM ";
2030 PRINT LOW(0);"  TO ";HIGH(0):PRINT :PRINT
2040 PRINT ,"SELECT NUMBER OF COLUMNS IN HISTOGRAM: ":PRINT
2050 DATA " 4"," 6"," 8","12","16","24"
2060 RESTORE 2050:PRINT :FOR I= 1TO 6:READ COLUMNS$
2070 PRINT ,,"";CHR$ (64+ I);"  ";COLUMNS$;" COLUMNS"
2080 PRINT :NEXT I
2110 PRINT ,,:INPUT "SELECT A - F: ";J$:J= ASC (J$)- 64:REM
2120 IF J< 1OR J> 6THEN PLOT 28,11:GOTO 2110
2130 RESTORE 2050:FOR I= 1TO J:READ COLUMNS$:NEXT I
2140 COLUMNS= VAL (COLUMNS$)
```

Listing 1 continued on page 102



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Listing 1 continued:

```
2150 FOR I= 1TO COLUMNS:ARRAY(I,1)= 0:NEXT I:REM ZERO SUMS
2160 JUMP= SCALE(0)/ COLUMNS:FOR ITEM= 1TO NUMBER
2170 GROUP= 1+ INT ((ARRAY(ITEM,0)- LOW(0))/ JUMP)
2180 ARRAY(GROUP,1)= ARRAY(GROUP,1)+ 1:NEXT ITEM
2200 PLOT 6,COLOUR(1),12:AXIS= 0:GOSUB 11400
2210 GOSUB 11900:AXIS= 1:GOSUB 10210:REM BIG(1)
2220 DEF FN E(I)= EXP (- ((MEAN(0)- I)^ 2/ (2* DEVIAT(0)^ 2)))
2225 DEF FN F(I)= DEVIAT(0)* COLUMNS* 2.50663
2230 DEF FN G(I)= NUMBER* SCALE(0)* FN E(I)/ FN F(I):REM GAUSS
2240 IF FN G(MEAN(0))> BIG(1)THEN BIG(1)= FN G(MEAN(0))
2250 GOSUB 9020:REM FRAME
2260 PLOT 6,COLOUR(4):REM GAUSSIAN CURVE
2270 FOR I= LOW(0)TO HIGH(0)STEP (HIGH(0)- LOW(0))/ 24
2280 AXIS= 0:PLACE= I:GOSUB 10700
2290 AXIS= 1:PLACE= FN G(I):GOSUB 10700
2300 ON 1- (I= LOW(0))GOSUB 11020,11010:NEXT I
2310 FOR AXIS= 0TO 1:PLACE= LOW(AXIS):GOSUB 10700:NEXT AXIS
2320 PLOT 6,COLOUR(3):GOSUB 11010:FOR I= 1TO COLOUMNS:REM HISTO
2330 AXIS= 1:PLACE= ARRAY(I,AXIS):GOSUB 10700:GOSUB 11020
2340 AXIS= 0:PLACE= LOW(AXIS)+ I* JUMP:GOSUB 10700:GOSUB 11020
2350 AXIS= 1:PLACE= LOW(AXIS):GOSUB 10700:GOSUB 11020:NEXT I
2355 GOSUB 11900:GOSUB 11800:IF K$= "C"THEN 2010:REM COLORS
2360 PLOT 3,0,31,6,4,11,3,15,31
2370 INPUT "NEW DATA, HISTOGRAM, SAVE OR MENU: ";I$
2375 IF I$= "M"THEN RETURN
2380 IF I$= "D"THEN 5
2385 IF I$= "S"THEN GOSUB 11500:GOTO 2355
2390 ON - (I$= "H")GOTO 2010:GOTO 2355
3990 REM
3991 REM
3992 REM   SUBROUTINE TO ANALYSE DATA AND PLOT REGRESSION
3993 REM
4000 GOSUB 10000:REM DATA FOR LINEAR REGRESSION
4010 GOSUB 4400:REM BORDERS AND LINE
4030 GOSUB 11000:GOSUB 11900:REM POINT PLOT AND PAUSE
4035 GOSUB 11800:IF K$= "C"THEN GOSUB 4730:GOTO 4030:REM COLORS
4040 PLOT 3,0,31,6,4,11,3,15,31
4050 INPUT "NEW DATA, REGRESSION, SAVE OR MENU: ";I$
4060 IF I$= "D"THEN 5
4070 IF I$= "R"THEN 4010
4075 IF I$= "S"THEN GOSUB 11500:GOTO 4040
4085 IF I$= "M"THEN RETURN
4090 GOTO 4040
4400 PLOT 6,47,14,12,3,17,7:REM SELECT REGRESSION
4410 PRINT "S E L E C T   R E G R E S S I O N":PRINT :PRINT
4420 DATA "LINEAR:         Y = AX + B",""
4430 DATA "EXPONENTIAL:   10^Y = AX + B","10^"
4440 DATA "LOGARITHMIC:  LOG10(Y) = AX + B","LOG(10)"
4450 DATA "RECIPROCAL:    1/Y = AX + B","1/"
4470 TITLES= 4
4480 RESTORE 4420:FOR I= 1TO TITLES:READ TITLE$,PREFIX$
4490 PLOT 10,9,9:PRINT I,TITLE$:NEXT I
4500 PRINT :PRINT ,,,:INPUT "SELECT REGRESSION: ";J
4510 IF J< 1OR J> TITLESTHEN PLOT 28,11,28:GOTO 4500
4520 RESTORE 4420:FOR I= 1TO J:READ TITLE$,PREFIX$:NEXT I
4525 ON JGOTO 4530,4540,4550,4560
```

Listing 1 continued on 106

Chief Relief

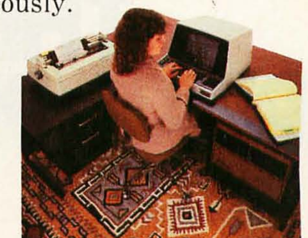
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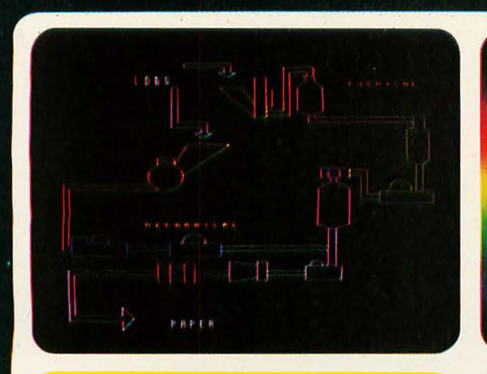
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A FEW OF THE FEATURES THAT GIVE TERAK THE EDGE IN PRICE/PERFORMANCE

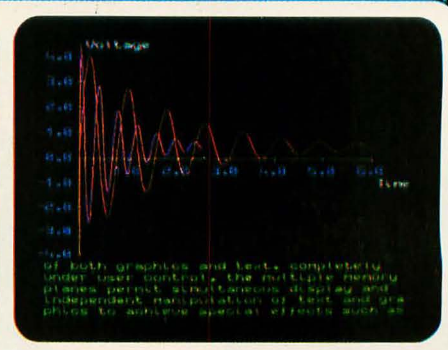
While some of the features of Terak's new 8600 can be found in other computer graphic systems, no other system in the $5K-$20K price class (and even those costing thousands more) provides a comparable combination of features and benefits. Features such as

Low Entry Cost The basic 8600 color system is priced at about $15,000. It can be upgraded to higher resolution and a greater number of colors, but even fully expanded it still comes in at less than $19,000.

Or, you can start with a black and white system for less than $8,500 and upgrade to color at any time by the addition of a color processor and monitor.







Simultaneous Graphic/Text Display

The 8600 offers outstanding control and formatting of both graphics and text. Completely under user control, the multiple memory planes permit simultaneous display and independent manipulation of text and graphics to achieve special effects such as overlays, scrolling and zoning. This capability, in conjunction with Terak's unique flexible character generation, enables the 8600 to present visual displays that are unequalled by any other system of its class.

Broad Spectrum of Color Selection

The number of color maps and the colors in each map is completely under software control. With a 6-plane memory (640 x 480 x 6), up to 64 colors can be displayed on the screen simultaneously. With a 3-plane memory (320 x 240 x 3), up to 8 simultaneous colors can be displayed from any one of eight color maps. The output of the color map produces eight levels each for red, blue and green. The result is the selection of 512 possible levels of intensity, saturation and hue. Switching from map to map is under software control.

Zoning

The 8600 monitor screen can be divided into a maximum of four variable size zones. In a typical application, the upper three zones can display graphics while the lower zone displays text. The text can be scrolled or slow scrolled while the graphics are changing to coincide with the text changes.

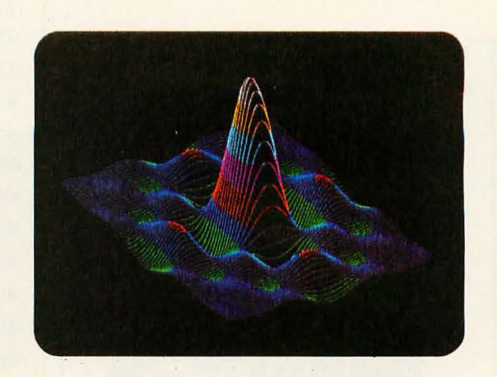
Dual Processors For Speed and Flexibility The two 16-bit processors (each with its own memory) are assigned those tasks which they can accomplish most efficiently and with the fastest throughput. The result is more available user space in memory, faster processing and increased flexibility of operation.

DEC Based Hardware and Software The DEC based hardware and software includes the LSI-11 main processor, RT-11 operating system and Q bus compatibility. As a result, the 8600 will support a variety of software and easily integrates peripheral devices.

USCD Pascal, Too The 8600 also supports the easy to use USCD Pascal operating system for program development, text editing, word processing and interactive applications.

Siggraph Core Standards, 2D1 Level Graphic support is provided for USCD Pascal and RT-11 for Fortran, Basic and Pascal.

The Other Reasons? Add such things as graphics display list processing, a high resolution quadrant, four modes of display blanking, emulation, remote on-line diagnostics, etc. The list goes on and on. But to fully appreciate the system you should see one in action. We'll be happy to set up an appointment. Just contact us.



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DYNAMIC FEATURES

The 8600 also offers several dynamic features that are impossible to illustrate and must be seen to fully appreciate.

Flexible Character Generation

Unlike the rigid cell sizes of many graphic display systems, the 8600 character generation is under software control. Characters can be programmed to any size or shape including the creation and display of foreign languages such as Arabic, Hebrew, Russian, etc., mathematical symbols, primitives, specially configured letters, characters or symbols and a host of others.

Fill Algorithms

Terak's fill algorithms are fast and allows you to fill the inside of simple or complex geometric figures without calculating points. This not only helps define charts, graphs, etc., but greatly enhances the appearance of presentation material.

Smooth or Line Scrolling

The speed of the vertical, bi-directional scrolling is under operator control. It can be slowed down for text editing or speeded up for search. And, unlike most terminals that jump a line at a time, the 8600 moves in increments of one scan line. The result is a smooth moving text that is easy to read.

External Video Synch

The 8600 can be synchronized to receive externally generated RGB signals or transmit 8600 signals to external video monitors. This lets you combine and/or overlay internally and externally generated characters and graphics onto a single screen if mixing hardware is incorporated in the system.

Listing 1 continued:

```
4530 DEF FN F(I)= I:GOTO 4600:REM LINEAR
4540 DEF FN F(I)= 10^ I:GOTO 4600:REM EXPONENTIAL
4550 DEF FN F(I)= LOG (I)/ 2.30259:GOTO 4600:REM LOG BASE 10
4560 DEF FN F(I)= 1/ I:GOTO 4600:REM RECIPROCAL
4600 XYSUM= 0:REM PREPARE REGRESSION
4610 FOR ITEM= 1TO NUMBER:ARRAY(ITEM,1)= FN F(ARRAY(ITEM,2))
4620 XYSUM= XYSUM+ ARRAY(ITEM,0)* ARRAY(ITEM,1):NEXT ITEM
4625 LABEL$(1)= PREFIX$+ LABEL$(2):PLOT 6,COLOUR(1),12
4630 FOR AXIS= 0TO 1:GOSUB 11400:NEXT AXIS
4640 I= NUMBER* XYSUM- SUM(0)* SUM(1)
4645 SLOPE= I/ (NUMBER* SQUARESUM(0)- SUM(0)^ 2)
4650 INCEPT= (SUM(1)- SLOPE* SUM(0))/ NUMBER
4660 COEFFICIENT= SLOPE* DEVIAT(0)/ DEVIAT(1)
4662 PLOT 3,20,17:PRINT "SLOPE:          ";SLOPE
4664 PLOT 3,20,19:PRINT "INTERCEPT:      ";INCEPT
4666 PLOT 3,20,21:PRINT "CORR. COEFF:  ";COEFFICIENT
4668 GOSUB 11900
4670 GOSUB 10200:REM BIG & LITTLE
4680 ARRAY(NUMBER+ 1,0)= LITTLE(0)
4690 ARRAY(NUMBER+ 1,1)= INCEPT+ SLOPE* ARRAY(NUMBER+ 1,0)
4700 ARRAY(NUMBER+ 2,0)= BIG(0)
4710 ARRAY(NUMBER+ 2,1)= INCEPT+ SLOPE* ARRAY(NUMBER+ 2,0)
4720 NUMBER= NUMBER+ 2:GOSUB 10200:NUMBER= NUMBER- 2:REM LIMITS
4730 GOSUB 9020:PLOT 6,COLOUR(4):REM PREPARE GRAPH
4740 FOR ITEM= NUMBER+ 1TO NUMBER+ 2:FOR AXIS= 0TO 1:REM LINE
4750 PLACE= ARRAY(ITEM,AXIS):GOSUB 10700:NEXT AXIS
4760 ON 2+ (ITEM= NUMBER+ 1)GOSUB 11010,11020:NEXT ITEM:RETURN
11392 REM
11393 REM
11394 REM        SUBROUTINE TO ANALYZE ARRAY(NUMBER,AXIS)
11395 REM
11396 REM        CALCULATES     MEAN(AXIS)
11397 REM        AND PRINTS:    DEVIAT(AXIS)
11398 REM                       ERR(AXIS)
11399 REM
11400 SUM(AXIS)= 0:SQUARESUM(AXIS)= 0:REM STATISTICS
11405 FOR ITEM= 1TO NUMBER
11407 SUM(AXIS)= SUM(AXIS)+ ARRAY(ITEM,AXIS)
11410 SQUARESUM(AXIS)= SQUARESUM(AXIS)+ ARRAY(ITEM,AXIS)^ 2
11415 NEXT ITEM
11420 MEAN(AXIS)= SUM(AXIS)/ NUMBER
11430 I= SQUARESUM(AXIS)- SUM(AXIS)^ 2/ NUMBER
11440 DEVIAT(AXIS)= SQR (I/ (NUMBER- 1))
11450 ERR(AXIS)= DEVIAT(AXIS)/ SQR (NUMBER)
11460 I= 20+ 20* AXIS:PLOT 3,I+ 3,5:PRINT LABEL$(AXIS)
11465 PLOT 3,0,9:PRINT "MEAN:":PLOT 3,I,9:PRINT MEAN(AXIS)
11470 PLOT 3,0,11:PRINT "STAN. DEV:"
11475 PLOT 3,I,11:PRINT DEVIAT(AXIS)
11480 PLOT 3,0,13:PRINT "STAN. ERROR:"
11485 PLOT 3,I,13:PRINT ERR(AXIS):RETURN
11495 REM
11496 REM
11497 REM        ABBREVIATED SUBROUTINE
11498 REM        TO SAVE IMAGES
11499 REM
11500 PLOT 6,COLOUR(2),3,0,31,11:REM SAVE ON DISK
11540 PLOT 27,4:PRINT "SAVE SCREEN.DIS 6000-6FFF":PLOT 27,27
11550 RETURN
```

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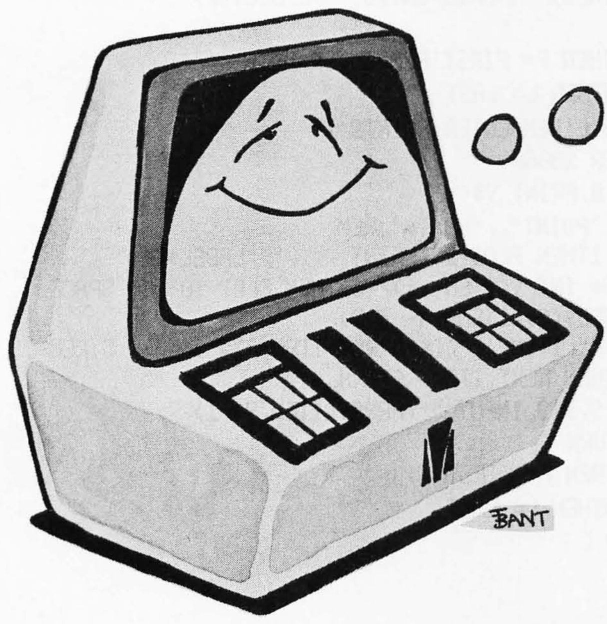
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Listing 2: *Programs for monthly analysis graph. Because this program modifies some of the previously written subroutines, this program should be added to the subroutines given in listing 1 of Part 1 of this article. (If the subroutines are added to this listing, the program will not run correctly.)*

```
5 REM KY 5 REM      GRAPHS. (C)  A.W.GROGONO.  AUG. 1979
6 REM        MONTHLY ANALYSIS FOR UP TO 7 YEARS
40 RESTORE :CLEAR 200:DIM I$(12)
50 DATA 1,2,1,2,4,6,3,5,7:FOR I= 1TO 9:READ COLOUR(I):NEXT I
90 PLOT 29,27,24,15,14,2,255,6,1,12,3,16,3:REM CLEAR PAGE
98 REM
99 REM
252 PRINT "M O N T H L Y   C O M P A R I S O N":PRINT
254 PRINT :PRINT ,,"THIS PROGRAM ALLOWS YOU TO"
255 PRINT :PRINT ,,"ENTER PROFITS OR INCOME ETC"
256 PRINT :PRINT ,,"MONTHLY FOR UP TO 7 YEARS."
257 PLOT 10,10,10,9,9:PRINT "YOU CAN START AND FINISH"
258 PRINT :PRINT ,,"PART WAY THROUGH THE FIRST"
259 PRINT :PRINT ,,"AND LAST YEARS RESPECTIVELY"
260 PRINT :PRINT ,,"BY ENTERING THE NUMBERS OF"
261 PRINT :PRINT ,,"OF THESE MONTHS."
264 PRINT :PRINT :PRINT ,,"1.  CREATE GRAPH":REM
266 PRINT :PRINT ,,"2.  ERASE/REVIEW OLD GRAPHS"
267 PRINT :PRINT ,,"3.  RETURN TO MAIN MENU":PRINT :PRINT ,,,
268 INPUT "ENTER 1 - 3: ";I:IF I= 2THEN GOSUB 7000:GOTO 5
270 IF I= 3THEN LOAD "MENU":RUN
272 PLOT 12,3,16,5:INPUT "ENTER # OF YEARS: ";N
274 FOR Y= 1TO N:PLOT 6,Y,10,9,9:PRINT "ENTER YEAR NUMBER";Y;
275 INPUT ": ";Y$(Y):NEXT Y:PLOT 10,9,6,1:PRINT "FOR YEAR ";
276 PRINT Y$(1);:INPUT ", ENTER # OF FIRST MONTH, 1-12: ";FIRST
277 PLOT 10,9,6,N:PRINT "FOR YEAR ";Y$(N);
278 INPUT ", ENTER # OF  LAST MONTH, 1-12: ";LAST
279 GOSUB 10000:FOR Y= 1TO N:GOSUB 10030:NEXT Y
280 LITTLE(0)= 0:BIG(0)= 12
281 LITTLE(1)= ARRAY(FIRST,2):BIG(1)= ARRAY(FIRST,2)
282 FOR Y= 1TO N:FOR ITEM= 1TO 12
283 ARRAY(ITEM,1)= ARRAY(ITEM,Y+ 1):REM COPY NEXT YEAR
284 NEXT ITEM:AXIS= 1:GOSUB 10215:NEXT Y:REM FIND BIG, LITTLE
285 GOSUB 600:REM SELECT ZERO END FOR Y-AXIS
286 GOSUB 10500:REM FRAME
287 FOR Y= 1TO N:F= 1:IF Y= 1THEN F= FIRST
288 L= 12:IF Y= NTHEN L= LAST
300 FOR ITEM= FTO L:ARRAY(ITEM,1)= ARRAY(ITEM,Y+ 1)
302 NEXT ITEM
320 GOSUB 11100:REM LINE
322 PLOT 3,59,20+ N- Y* 3:PRINT Y$(Y):REM YEAR IN GRAPH-COLOR
324 NEXT Y:GOSUB 11500:REM SAVE
325 GOSUB 11800:IF K$= "C"THEN GOTO 286:REM COLORS
330 PLOT 3,15,31:INPUT "ENTER A TO ALTER Y-AXIS ZERO: ";I$
340 IF I$= "A"THEN 280:REM NEW ZERO
350 GOTO 5
600 PLOT 6,6,14,12,3,16,5:PRINT LABEL$(1):PLOT 15,6,1,10,10
602 PRINT ,,"SELECT LENGTH OF SCALE":PRINT
610 PRINT :PRINT ,,"1.  WITH ORIGIN STARTING AT ZERO"
620 PRINT :PRINT ,,"2.  MAXIMUM ENLARGEMENT"
630 PRINT :PRINT ,,,:INPUT "SELECT 1 OR 2: ";I
640 IF I= 1THEN LITTLE(1)= 0
650 GOSUB 10300:RETURN :REM SCALE VALUES
```

Listing 2 continued on page 110

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Listing 2 continued:

```
9990 REM
9991 REM
9992 REM        ALTERATIONS TO SUBROUTINES:
9993 REM
9994 REM             10000  DATA ENTRY
9995 REM             10200  FIND BIG AND LITTLE
9996 REM             10500  DRAW BORDERS ETC.
9997 REM             11000  PLOT POINTS AND LINES
9998 REM             11800  COLOR SELECTION
9999 REM
10000 PLOT 6,1,12,14,3,18,13:REM DATA ENTRY
10010 PRINT "D A T A   E N T R Y"
10015 PLOT 10,9,9:INPUT "GRAPH TITLE: ";TITLE$
10020 NUMBER= 12
10021 DIM ARRAY(NUMBER,N+ 1)
10022 LA$(0)= "JAN FEB MAR APR MAY JUN JLY AUG SEP OCT NOV DEC"
10025 IF CHOICE= 1THEN LABEL$(1)= "NUMBER":GOTO 10030
10026 PLOT 10,9,9:INPUT "Y-AXIS UNITS: ";LABEL$(1)
10028 RETURN
10030 F= 1:IF Y= 1THEN F= FIRST:REM ENTER DATA
10032 L= 12:IF Y= NTHEN L= LAST
10035 FOR ITEM= FTO L:REM ENTER POINTS
10040 IF ITEM> FTHEN 10060
10045 PLOT 12,3,17,0:PRINT Y$(Y)
10050 PRINT :PRINT "POINT",,"MONTH":REM
10055 IF CHOICE< > 1THEN PLOT 28:PRINT ,,,,"";LABEL$(1)
10060 IF ITEM- 1= 6* INT ((ITEM- 1)/ 6)THEN PLOT 10:REM SPACE
10065 I$= MID$ (LABEL$(0),ITEM* 4- 3,3)
10070 PRINT :PRINT "";ITEM,,"";I$:ARRAY(ITEM,0)= ITEM- .5:REM
10075 IF CHOICE= 1THEN NEXT ITEM:RETURN
10080 PLOT 28,18,9,9,9,9:INPUT "";ARRAY(ITEM,Y+ 1)
10085 NEXT ITEM:RETURN
10215 F= 1:IF Y= 1THEN F= FIRST
10216 L= 12:IF Y= NTHEN L= LAST
10217 FOR ITEM= FTO L
10498 REM
10499 REM
10557 IF AXIS= 0THEN NEXT AXIS
10662 PLOT 3,MAXSCREEN(0)/ 2- LEN (LABEL$(0))
10664 PLOT 33- MINSCREEN(1)/ 4:PRINT LABEL$(0)
10998 REM
10999 REM
11150 PLOT 6,COLOUR(2+ Y):FOR ITEM= FTO L:FOR AXIS= 0TO 1
11170 ON 2+ (FLAG= 1OR ITEM= F)GOSUB 11010,11020
11798 REM
11799 REM
11845 DATA "GRAPH3","GRAPH4","GRAPH5","GRAPH6","GRAPH7"
11850 FOR J= 1TO N+ 2:READ I$:PLOT 3,16,9+ 2* J:PRINT "FOR ";I$;
```

Text continued from page 98:
independent (X) variable is the month of the year, while the dependent (Y) variable is the income in dollars for 1 month; four variables (the income in each of 4 years) are plotted on this graph.

When you run the monthly analysis graph program (by adding listing 2 to the subroutine lines of listing 1 in last month's article), you are asked for the numbers of the years to be graphed, followed by the beginning month for the first year and the ending month of the last year to be graphed. (This program is written to account for the possibility that you may not have all the data for the



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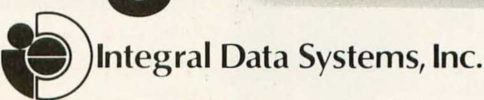
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beginning and ending years.) After the title, Y-axis label, and monthly data values have been entered, the program calculates and displays the data on the color video display screen. The Y-axis can start at zero (as in photo 4a), or it can start at some nonzero value to allow maximum use of the Y-axis (as in photo 4b). As before, the colors used in the graph may also be changed.

Summary

The programs were written with readability as the main objective. You may wish to decrease the memory needed to store these subroutines by omitting REMark statements and putting multiple statements on a line. Care should be exercised, however, when compressing statement lines because some subroutines are written to be entered at more than one point.

The Compucolor PLOT statement was more fully explained in last month's article.

The four kinds of graphs described in this article demonstrate how the graphics subroutines can be combined (with or without modification) to form complex programs that produce specialized graphs. These subroutines can be used to substantially reduce the time required to create a given graph. In addition, the use of photographed color images (as opposed to color slides of conventionally produced graphs) can significantly decrease both the time and cost necessary to add color graphs to a slide presentation. ■

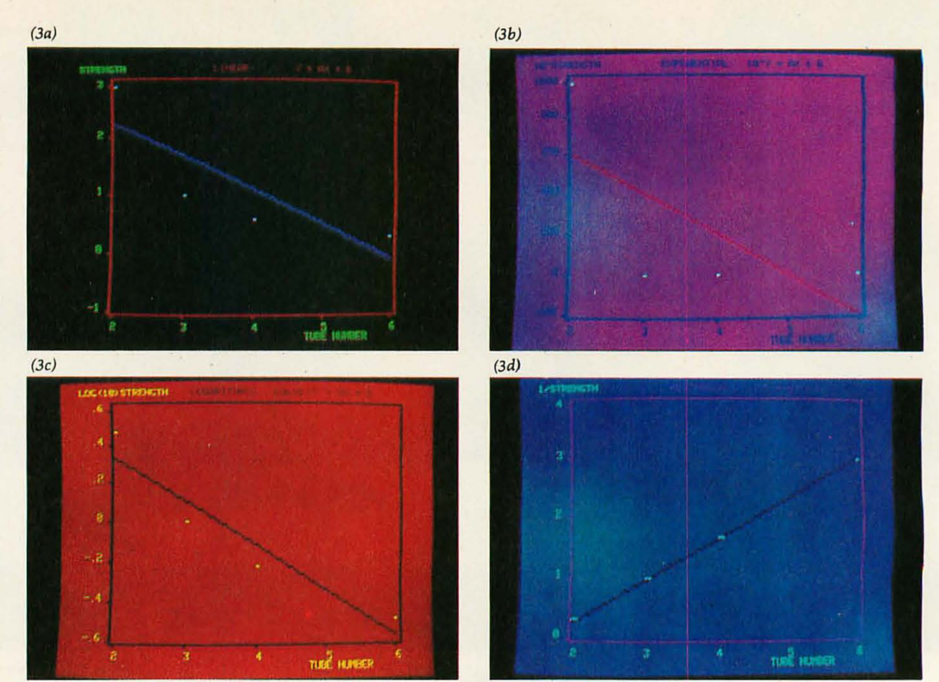


Photo 3: *Examples of regression charts. The program in listing 1 allows the entered data to be graphed using different colors and different types of regression—linear (photo 3a), exponential (photo 3b), logarithmic (photo 3c), or reciprocal (photo 3d).*

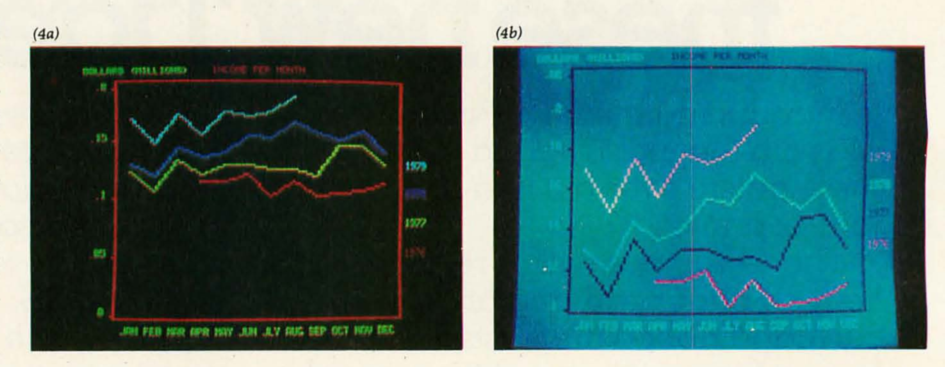
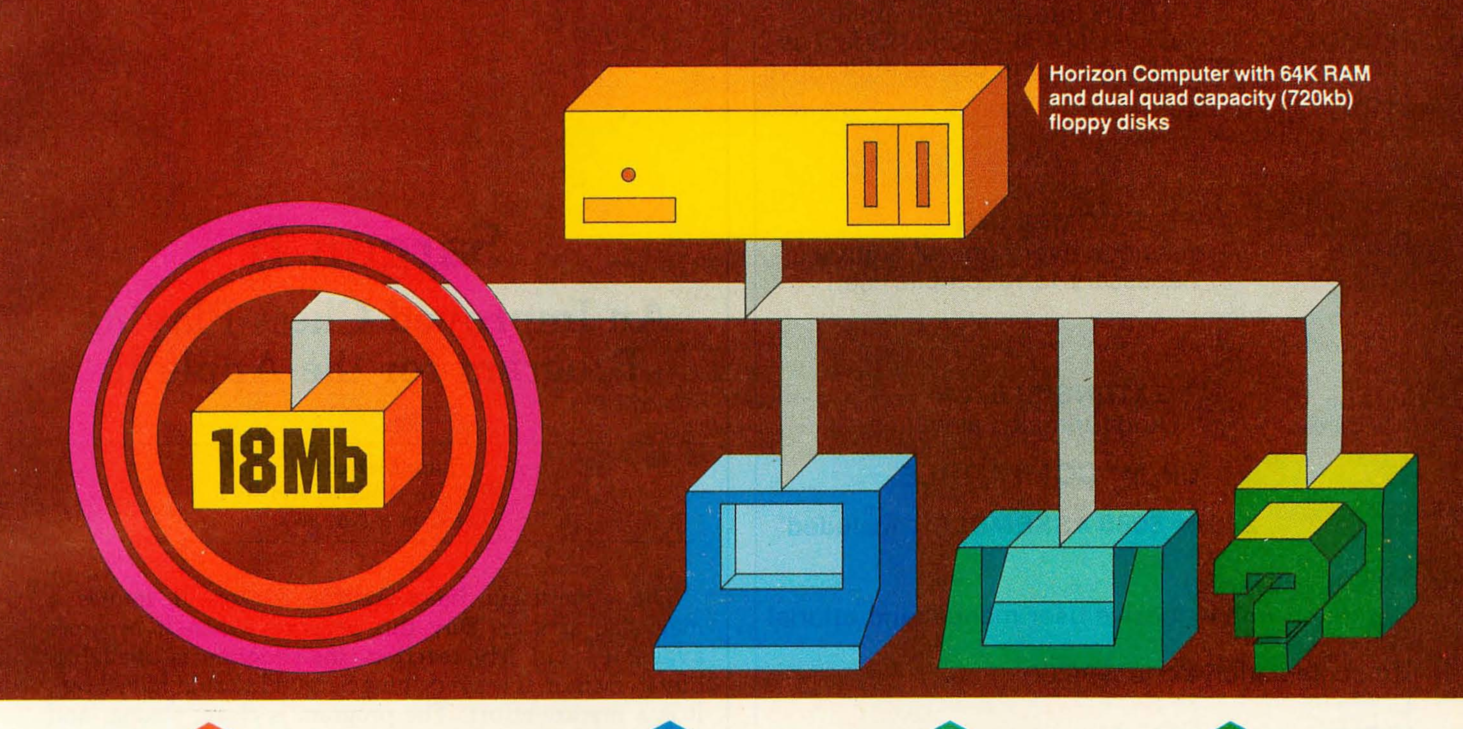


Photo 4: *Examples of monthly analysis graphs. These graphs superimpose a variable plotted over a 12-month span for up to seven 12-month graphs. The Y-axis can start either at zero (photo 4a) or at some predefined value (photo 4b).*

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Product Review

Sargon II
An Improved Chess-Playing Program for the Apple II

John Martellaro
2929 Los Amigos, Apt B
Las Cruces NM 88001

The advertising literature for Sargon II quotes a magazine article: "Buy this program when it becomes available. . . ." My reaction: the program is available; buy it. Sargon II is everything Sargon I should have been. It is a mature effort. The program is clean, strong, and debugged. Nearly every deficiency of Sargon has been corrected:

- Sargon II has book openings.
- Sargon II recognizes stalemates.
- The levels of play are geared to clock time instead of ply search. As the pieces disappear, the ply search goes deeper, keeping the *time* relatively constant.
- Setting up a board position is easier.
- The program shows the move it is thinking of making.
- It will suggest a move for you.
- The graphics are new and very handsome.
- There is the much-asked-for asterisk prompt to indicate that the program is thinking.
- Every check is logged on the screen.
- Move entry is easier, but still not as easy as in Microchess 2.0.
- The playing strength is vastly improved.

Sargon II plays well. I play at an unofficial 1700+ United States Chess Federation (USCF) rating and have never lost a serious chess game to any microcomputer program (Boris 1978, Microchess 2.0, Sargon I), but I lost the first two trial games against Sargon II — mostly from being taken by surprise at its unwillingness to be bullied. Carelessness? Impatience?

After this appalling result, I promptly invited two friends over. They have official USCF ratings of 1650 and 1714, and the former player is extremely familiar with the openings.

We set Sargon II at level 3, the highest level that makes moves in tournament time. By our combined efforts, we cleaned Sargon II off the board — mostly by our



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familiarity with the standard opening moves.

The 1650-rated player, whose lifetime high rating is 1850, has played every available computer chess game, including large mainframe computers. None has ever survived his "fried-liver attack." [*The fried-liver attack involves placing the White King's Bishop on c4 and a White Knight on g5, attacking the weak King's Bishop pawn; or the equivalent setup for Black....***RSS**] Sargon II fared no better and succumbed in 13 moves.

Convinced now that Sargon II could be beaten, I rolled up my sleeves, got very mean, and again set the program for level 3. After 90 minutes of trekking through a bloody, grim Ruy Lopez opening, fending off a Queenside attack, and using my mobility on the Kingside, I broke through. On move 40, Sargon made a mistake (failure to look far enough ahead), and I blew its position wide open. But for that one mistake, the game would have been a draw.

During the dozen or so games I have played against Sargon II, I have lost only one more game and have made the following observations. Sargon II has much needed and clearly visible improvements over Sargon I. It castles at the most propitious time and actually seeks an opponent's weaknesses and tries to gain tactical advantages.

The pawn play is much improved. Sargon II senses the worth of passed pawns and actively tries to promote them. Sargon I had little use for pawns.

After our three-game "tournament" mentioned above, we set up an endgame position out of curiosity. We took White with King at c1 and pawns at c2, b2, and h2. We gave Sargon II a King at g8 and pawns at g7, h7, a7, and b7. This should be a won game for Black with careful

White (Sargon II)	Black (Three humans, rated 1700+, 1714, and 1650)
1. e2-e4	e7-e5
2. Ng1-f3	Nb8-c6
3. Bf1-b5	Ng8-f6
4. Nb1-c3	Nc6-d4
5. d2-d3	. . . .

This looks like a good developing move, but Sargon II needed to play a little more sharply here. 5.Nf3xe5 leads to a much better game for White.

5.	c7-c6
6. Bb5-a4	d7-d6
7. O-O	

It looks safe enough for Sargon II. He has castled and mobilized his pieces by move 7. Sargon I never managed that.

7.	Bc8-g4
8. Bc1-e3	

A critically weak move. The Black Knight is going to capture anyway. Why not Bc1-g5?

8.	Nd4xf3
9. g2xf3	Bg4-h3
10. Rf1-e1	

An unfortunate move to have to make. If White could have seen what was in store, he might have abandoned the Rook and moved the King to h1.

10. . . . . Nf6-h5

This clears the way for the Queen. An important move in the attack.

11. Qd1-d2

A clever and amusing trap by White. If we had played 11 . . . . Qd8-h4 to pour it on, then 12.Be3-g5, and we lose our Queen. We very nearly fell for it. So far, Sargon II has played like an intelligent, but inexperienced, player. This is the first "trap" I have seen set by a microcomputer chess program.

11. . . . . Qd8-f6

But at the last second, we don't fall for the trap and attack the weak pawn at f3 instead.

12. Nc3-d5?

A desperation move; White ignores the weak pawn at f3, but probably saw 12.Qd2-e2, Qf6-g6 check, and is ready to try anything.

12. . . . . Qf6xf3

It's all over now for White.

13. Nd5-c7 check	Ke8-d7
14. Ba4xc6 check	Kb7xc6

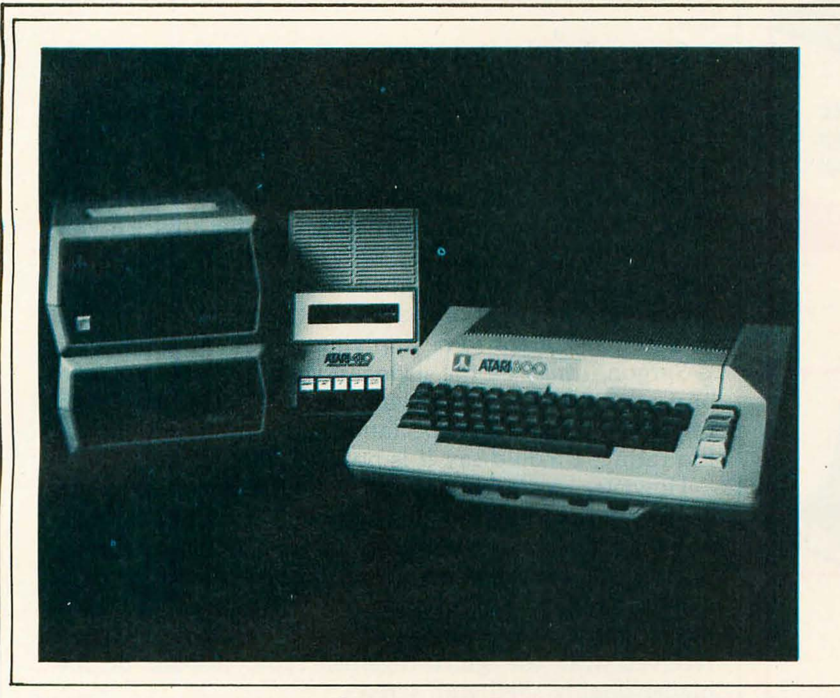
The horizon effect, trying to avoid fate: any human would have done the same.

15. Nc7xa8 Qf3-g2 checkmate

Table 1: *Score of a game played between Sargon II (with the White pieces) and three humans (with the Black pieces), one of whom is an openings expert. While Sargon lost the game, it went down fighting. This contest shows the style and limitations of the program, which played at level 3. The notation is algebraic.*

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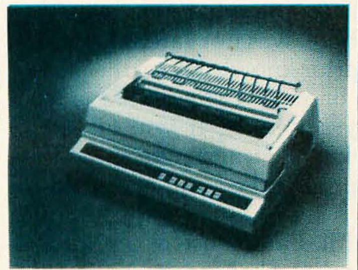
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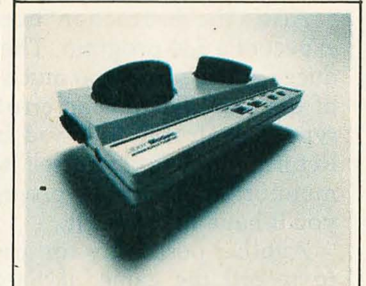
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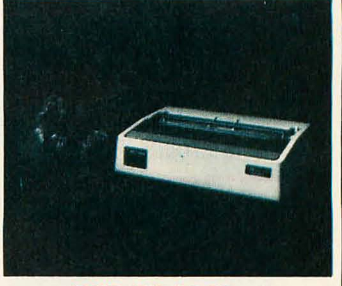
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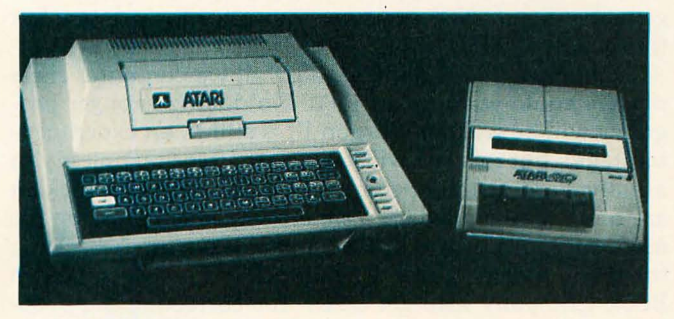
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play. At times, Sargon II pushed its look-ahead procedure to level 8. (This cannot be set from the keyboard.)

Sargon pushed its pawns carefully, but blundered by trying to fight on both fronts for too long. The program finally made a critical mistake and allowed us a draw. We wound up with just the two Kings on the board. Curiously at that point, instead of calling a draw Sargon's King started advancing toward our King, perhaps thinking that with a hidden dagger up its sleeve, it could finish us off. Such violence would be a patent violation of chess law.

Sargon II is the first chess program I have seen which has doubled its Rooks on a file with malice obviously intended. It is also the first program I've played that has actually set a trap. Perhaps this is a glimmer of artificial intelligence!

The program will suggest a move for you if you type control-K. You would be wise to ignore this advice if you are an experienced player. Why? These programs play well tactically but with poor strategy. Any suggested move will be devoid of the strategic thought which you, as a human, ought to be applying.

Sargon II may be the strongest chess program you can buy, dedicated chess-playing devices included. I am impressed beyond all expectation. If I were to estimate its Elo rating, I would say it is possibly 1500 at level 3.

However, as with any software product, there are some minor complaints. If you bought Sargon I for $20, you may flinch at buying Sargon II for $30 ($35 on floppy disk). Such a price seems hard to justify, and you would expect that for a $30 program, the packaging would be a little better. For example, the shell of the cassette I received was the glued-together type, instead of the higher-quality shell with screws.

Also, the instruction book is not what you would expect of a $30 program. The book was not carefully produced and assumes too much prior knowledge on the part of the user. There is an error on page 4 where it says to type a control-R followed by a Return. If you hit the Return, you'll find yourself helplessly transferred into the monitor, and since the program is locked and protected, you'll have to reload it.

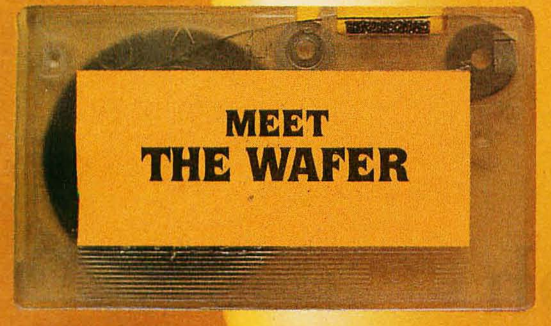
Another possibility for grief lies in the use of a printer to record the game. If Sargon II changes its decision about a move, it will overwrite the previous move. This works fine for a video display, but on a printer there would be a blob after two or more move changes.

About the only other request you might make of Sargon II is to have the listing of the entire game in memory instead of letting lines scroll off the top of the screen. Often a user gets too busy playing to record the game by hand. Not everyone can afford a printer; but this is a minor affair.

In summary, Sargon II is about all we computer chess players could wish for in 1980. No doubt, stronger programs will be written (Sargon III is still in an experimental stage), but this one will keep your attention unless you are a wizard in the openings. Dan and Kathe Spracklen are to be commended for a superb implementation on the 6502 microprocessor: in fact, I give them an A+ rating for the implementation. The Spracklens and the Hayden Book Company also get a A+ for correcting the problems in Sargon I, but unfortunately, Hayden gets a C on the packaging. ■

*[Next month the author reviews Sargon 2.5...***ed***]*

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Micrograph
Part 2: Video-Display Processor

E Grady Booch
4314 Driftwood Dr
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Part 1 of this article (BYTE, November 1980, page 64) presented some background on interactive computer-graphics systems, with an emphasis on the characteristics of display processors (the portion of the graphic system that produces the actual image). The instruction set for a color raster-scan graphics-display processor was also presented. Part 2 will feature the hardware for a low-cost display processor, called Micrograph, which implements this instruction set. You can find the essential characteristics of Micrograph listed in table 1. The processor's hardware, including a circuit description, construction hints, and enhancement ideas, will be the topic of the latter portion of this part of the series.

Block Diagram

As figure 1 indicates, Micrograph is relatively simple in terms of hardware: there is nothing tricky about its design. Micrograph is built around a Zilog Z80 microprocessor, which shares a bus with a video-display generator. The bus control arbitrates between the microprocessor and the display generator so that only one device is allowed to access the bus at a time.

Also connected to the system bus are several I/O (input/output) ports, which are used to communicate with a host computer. The I/O interface includes ports for transmission of data and instructions from the host computer and ports for the transmission of data and status to the host computer. Micrograph thus appears to the host computer as an intelligent peripheral. With this architecture, the display processor does not tie up the

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Table 1: *Summary of the characteristics of the Micrograph color-display system.*

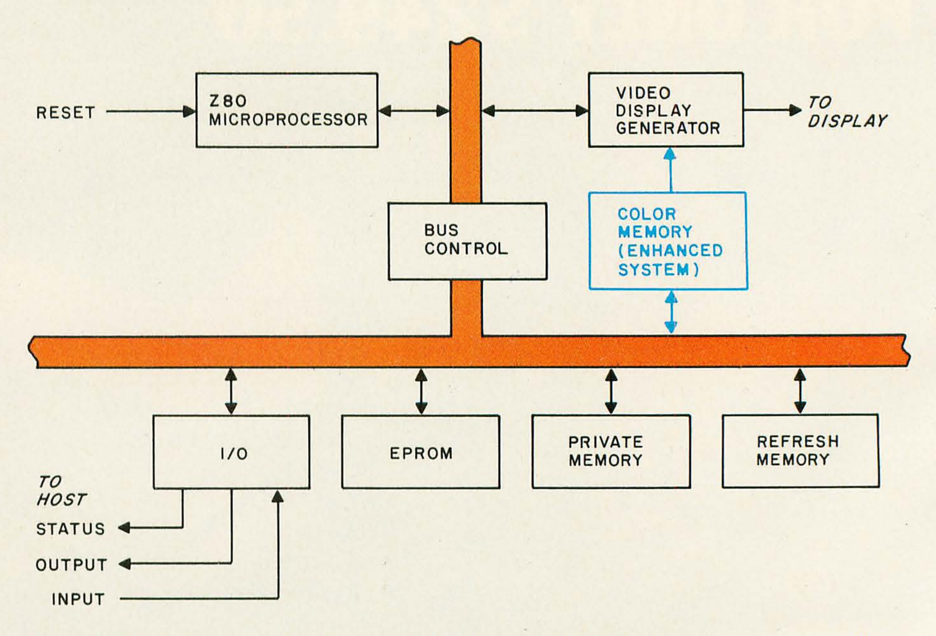


Figure 1: *Block diagram of Micrograph hardware. The Z80 microprocessor provides an active element for implementing the instruction set described in Part 1 of this article. By using a video-display generator device developed by Motorola, the hardware is simplified. The processor and display generator share a common bus that is separate from the host system's bus, so that Micrograph is a truly intelligent peripheral.*

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	0	0	x	x	x	0	1	black on green	black	
	0	0	x	x	x	1	0	orange on black	black	
	0	0	x	x	x	1	1	black on orange	black	
2	0	1	x	x	x	x	x	black, green, yellow, blue, red, buff, cyan, magenta, or orange (depends on color code)	black	64 by 32, eight colors
3	1	x	0	0	0	0	x	green, yellow, blue, red	green	64 by 64, four colors
	1	x	0	0	0	1	x	buff, cyan, magenta, orange	buff	
4	1	x	0	0	1	0	x	black, green	green	128 by 64, two colors
	1	x	0	0	1	1	x	black, buff	buff	
5	1	x	0	1	0	0	x	same as 3	green	128 by 64, four colors
	1	x	0	1	0	1	x	same as 3	buff	
6	1	x	0	1	1	0	x	same as 4	green	128 by 96, two colors
	1	x	0	1	1	1	x	same as 4	buff	
7	1	x	1	0	0	0	x	same as 3	green	128 by 96, four colors
	1	x	1	0	0	1	x	same as 3	buff	
8	1	x	1	0	1	0	x	same as 4	green	128 by 192, two colors
	1	x	1	0	1	1	x	same as 4	buff	
9	1	x	1	1	0	0	x	same as 3	green	128 by 192, four colors
	1	x	1	1	0	1	x	same as 3	buff	
10	1	x	1	1	1	0	x	same as 4	green	256 by 192, two colors
	1	x	1	1	1	1	x	same as 4	buff	

Table 2: *Summary of the modes available to the Micrograph user. The Motorola MC6847 Video-Display Generator integrated circuit supports other resolutions, which are not available in the systems presented here. The 6847 control signals include: two lines to select between alphanumerics, semigraphics, and graphics; three lines to select the graphics-mode resolution; a color-set select line; and an inverse-video select line.*

host computer's time but rather handles its own display refreshing.

EPROM (erasable programmable read-only memory) is required to store the approximately 2.6 K bytes of software that implements the Micrograph instruction set. (A discussion of this software will be presented next month in Part 3.) Finally, 2 K bytes of programmable memory are used to store software variables and data for a programmable character generator, and 6 K to 8 K bytes of programmable memory are used for the display buffer.

Note that there is a reference to "System II": this is an improvement to the basic Micrograph system that will be discussed later in this article.

Video-Display Generator

The secret to Micrograph's simplicity is Motorola's MC6847 video-display generator. This forty-pin integrated circuit performs all the necessary video timing and refresh functions needed to produce a truly inexpensive color-graphics display. The 6847 was actually designed for the 6800 family of microprocessors, but its control, address, and data structures are generalized enough to allow its use with almost any microprocessor. I chose the Z80 because it was convenient in terms of the software development tools I had available.

The 6847 has several modes of operation, including alphanumeric, semi-alphanumeric, and full graphics modes. The device offers several different graphics-display resolutions, including sixteen lines of thirty-two alphanumeric characters and 64 by 64 pixel, 128 by 64 pixel, 128 by 96 pixel, 128 by 192 pixel, and 256 by 192 pixel graphics. The circuit also produces up to eight different colors that can be displayed at one time. Of course, with memory size held constant as the resolution increases, the number of colors that can be displayed at one time decreases. For example, the 128 by 192 pixel resolution has four colors, and the 256 by 192 pixel resolution has two colors. (Table 2 summarizes the modes available to the Micrograph user.)

Ready for use with the 6847 is a companion device, the MC1372 color television video modulator. This circuit interfaces directly to the MC6847 to provide either an RF (radio-frequency) or composite-video television signal. This allows Micrograph to be connected directly to an unmodified color television. Both of these devices are obtainable from most Motorola distributors; and in single quantities, the MC6847 costs around $35 and the MC1372 costs around $5.

For those readers who would rather avoid the expense of building a complete version of Micrograph, the MC6847 will still offer a very inexpensive way to produce a color-graphics display. In the event that you wish to connect the video-display generator to an existing microcomputer, the following discussions are still applicable. However, the advantage of dedicating a microprocessor to control the video display is that the host computer doesn't have to wait while the video generator accesses display-refresh memory. Furthermore, the Micrograph instruction set allows the host processor to deal with manipulating images, rather than worrying about the overhead of scan-line conversion and otherwise maintaining the display.

Circuit Description

Figure 2 provides the complete schematics for Micrograph. As we noted in the block diagram, the Z80

Text continued on page 126

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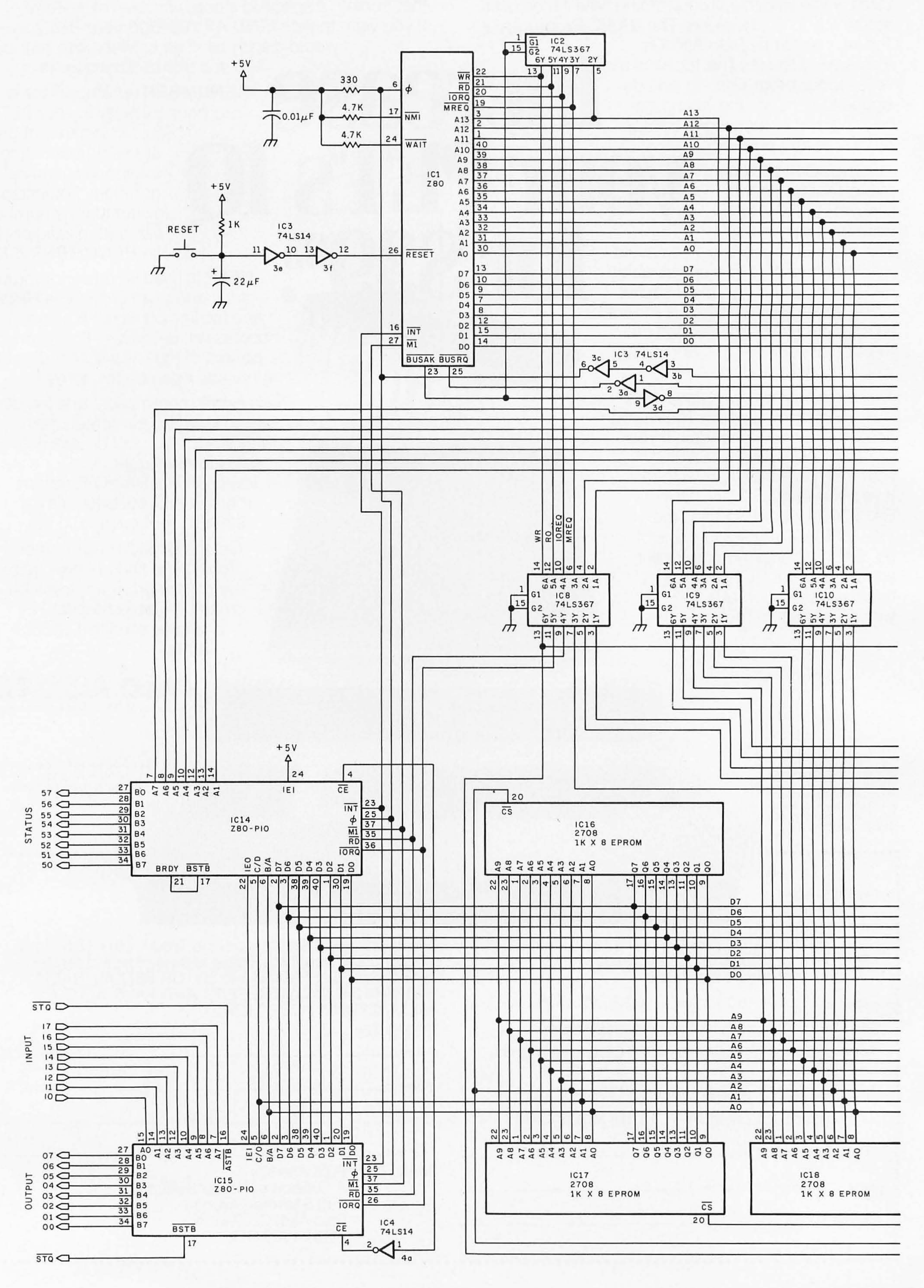
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330
4.7K
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IC1
Z80
IC2
74LS367
RESET
1K
IC3
74LS14
22μF
IC3 74LS14
WR
RD
IOREQ
MREQ
IC8
74LS367
IC9
74LS367
IC10
74LS367
IC14
Z80-PIO
STATUS
IC16
2708
1K X 8 EPROM
STQ
INPUT
OUTPUT
IC15
Z80-PIO
IC4
74LS14
IC17
2708
1K X 8 EPROM
IC18
2708
1K X 8 EPROM

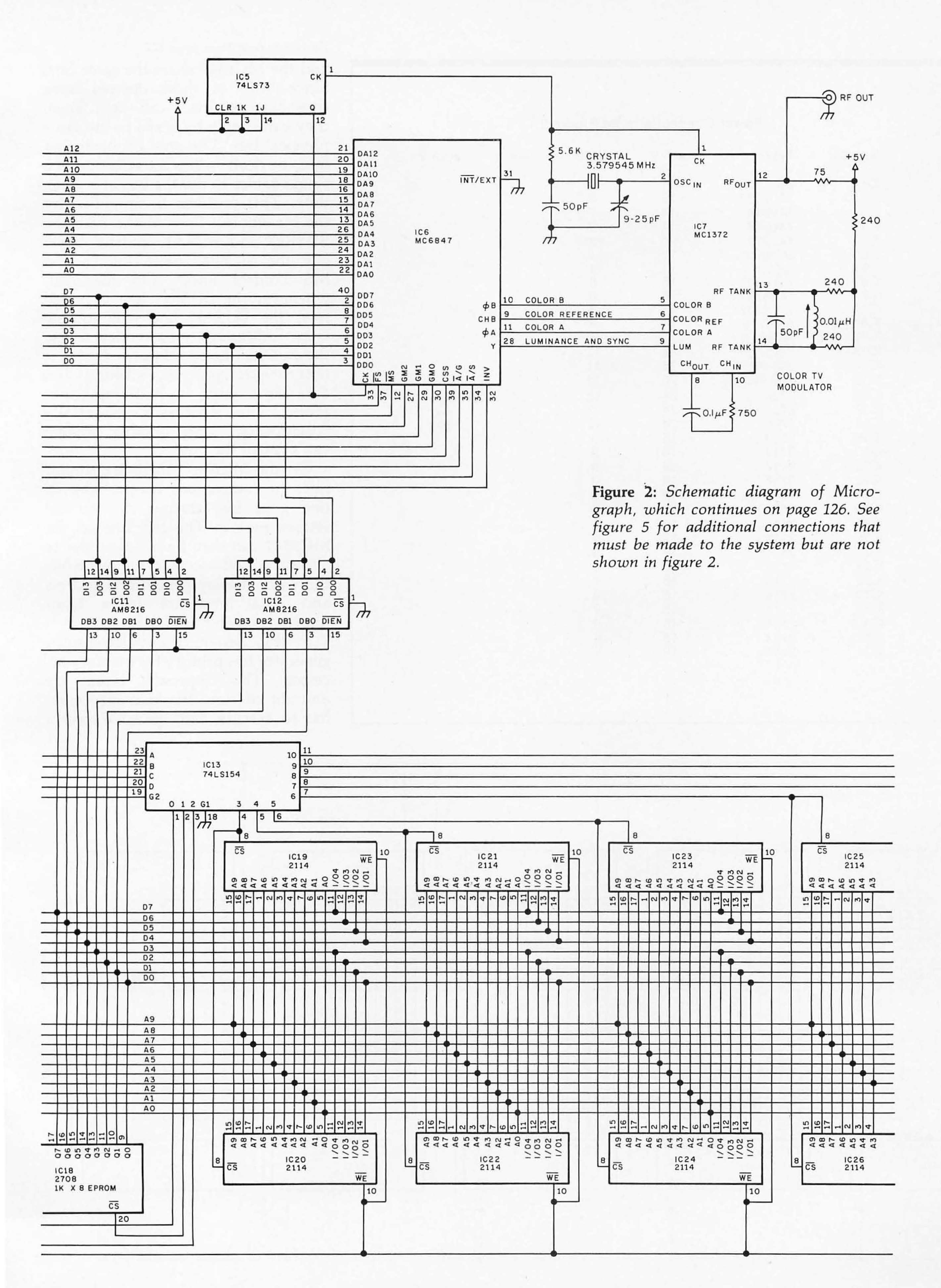


Figure 2: *Schematic diagram of Micrograph, which continues on page 126. See figure 5 for additional connections that must be made to the system but are not shown in figure 2.*

Power Connections for Figure 2

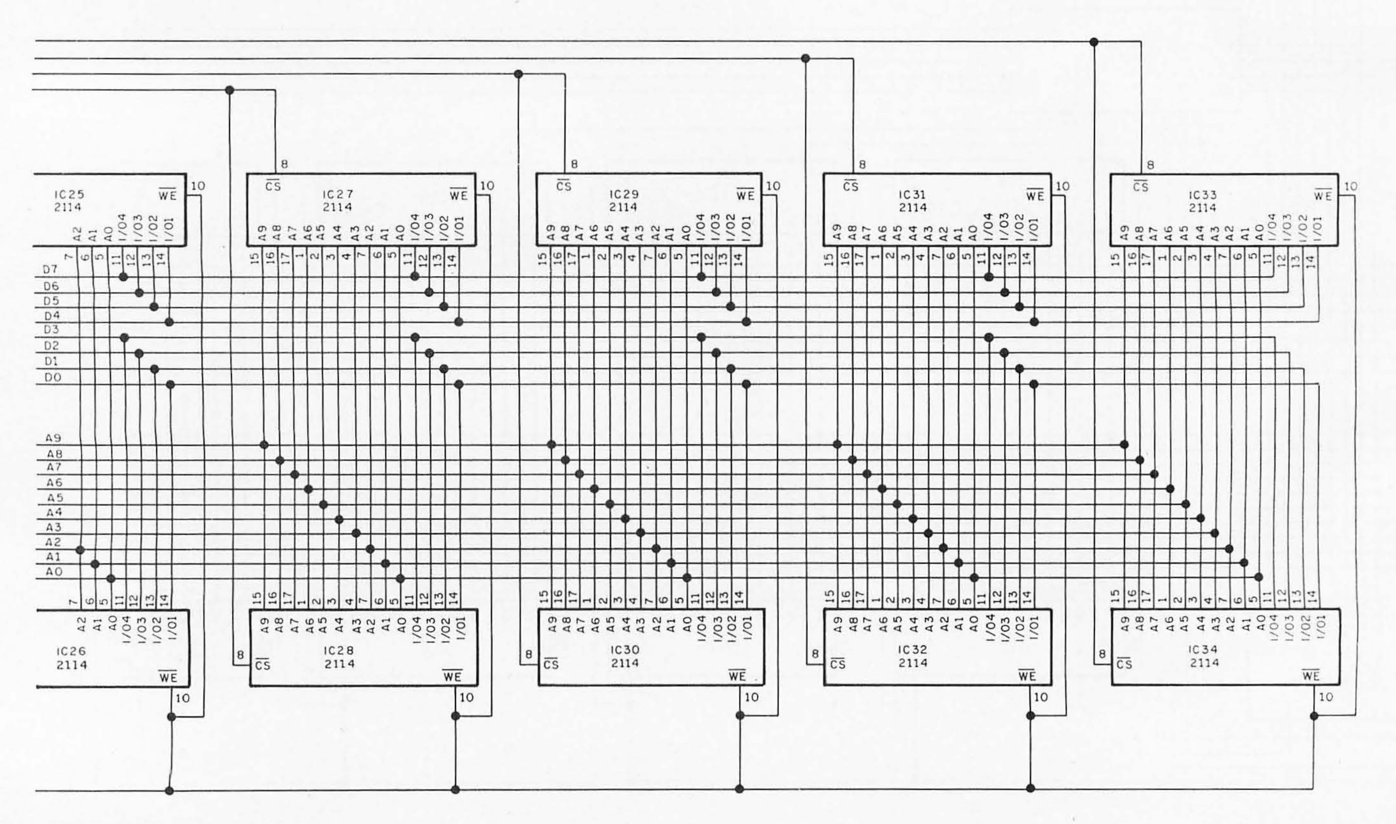
Number	Type	+5 V	GND	−5 V	+12 V
IC1	Z80	11	24		
IC2	74LS367	16	8		
IC3	74LS14	14	7		
IC4	74LS14	14	7		
IC5	74LS73	20	10		
IC6	MC6847	17	1		
IC7	MC1372	11	4		
IC8	74LS367	16	8		
IC9	74LS367	16	8		
IC10	74LS367	16	8		
IC11	AM8216	16	8		
IC12	AM8216	16	8		
IC13	74LS154	24	12		
IC14	Z80-PIO	26	11		
IC15	Z80-PIO	26	11		
IC16	2708	24	12	21	19
IC17	2708	24	12	21	19
IC18	2708	24	12	21	19
IC19	2114	18	9		
IC20	2114	18	9		
IC21	2114	18	9		
IC22	2114	18	9		
IC23	2114	18	9		
IC24	2114	18	9		
IC25	2114	18	9		
IC26	2114	18	9		
IC27	2114	18	9		
IC28	2114	18	9		
IC29	2114	18	9		
IC30	2114	18	9		
IC31	2114	18	9		
IC32	2114	18	9		
IC33	2114	18	9		
IC34	2114	18	9		

Text continued from page 122:

and the MC6847 share the same bus. Since both of these devices have three-state address and data lines, they can simply be wired to the same physical bus. The only problem that must be dealt with is the selection of a single device to use the bus at a given time. This problem is simplified by the bus-control lines of the Z80 (the $\overline{\text{BUSRQ}}$ and $\overline{\text{BUSAK}}$ control lines) and the MC6847 (with the $\overline{\text{FS}}$ and $\overline{\text{MS}}$ control lines). On the Z80, whenever the $\overline{\text{BUSRQ}}$ line is pulled low, the $\overline{\text{BUSAK}}$ line will go low later, indicating that a request to use the bus has been acknowledged. At that time, the processor's address and data lines enter a high-impedance mode, the processor essentially "disappears," and another system can control the bus.

On the MC6847, there are similar lines to control bus access. The $\overline{\text{FS}}$ line goes low during the vertical retrace period. The $\overline{\text{MS}}$ line on the MC6847 can then be brought low to allow the Z80 access to the bus while the video-display generator's address and data lines are in a high-impedance condition.

In this design, the video-display generator has priority for memory accesses. This approach limits the amount of time the microprocessor has to execute, but since we have a



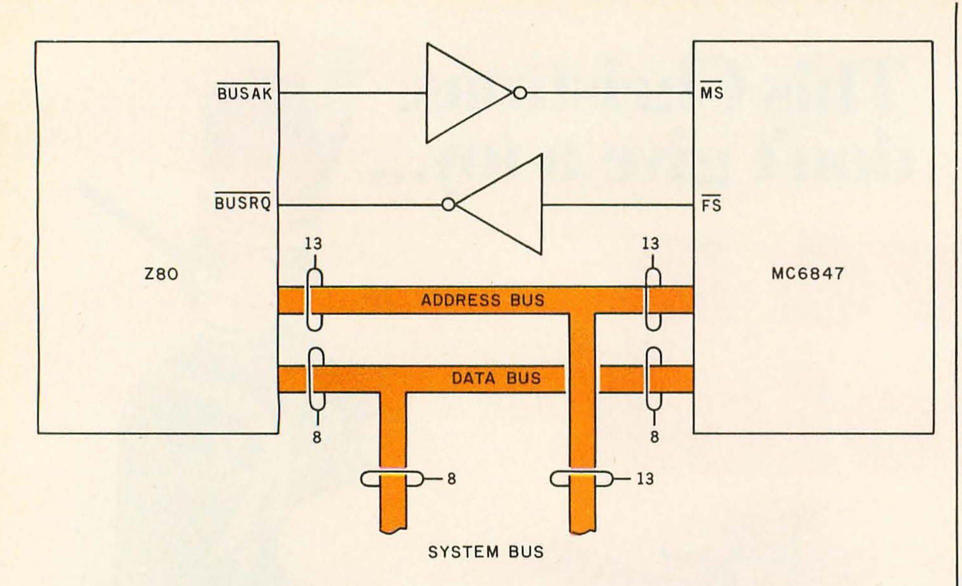


Figure 3: *Bus control. Since both the processor and the display generator must access memory, this simple arbitration scheme was devised to eliminate contention. The display generator is given priority. This approach limits the amount of time available to the processor for executing display "primitive" instructions, but it does help to maintain a stable display without the "tearing" effect that occurs when the display generator cannot read from memory when it needs to.*

dedicated processor, this is not really a problem. This approach also provides a stable display that will not "tear" since the video-display generator has the bus the entire time it needs it. As we see in figure 3, the bus control can be handled by two inverters, which are part of the 74LS14 Schmitt-trigger inverters in figure 2.

The Microprocessor

The discrete components shown near the Z80 in figure 2 are required for clock-line pull-up, as specified by Zilog. The nonmaskable interrupt ($\overline{\text{NMI}}$) and wait ($\overline{\text{WAIT}}$) lines are pulled high, since Micrograph operation requires neither wait states nor nonmaskable interrupts.

The Shared Bus

The Z80 and MC6847 address and data lines are simply tied together. The leftmost 74LS367 bus driver circuit is used to provide additional address (A13) and control ($\overline{\text{WR}}$, $\overline{\text{RD}}$, $\overline{\text{IOREQ}}$, and $\overline{\text{MREQ}}$) lines, which are active only when the MC6847 has control of the bus. These lines are needed since the MC6847 does not supply these signals. In this case, the address line (A13) is tied high to force addressing of the refresh memory in the 8 K to 16 K range of the Z80 microprocessor's address space.

The next integrated circuit, a 74LS14, is used to provide a manual and power-up reset circuit and also to drive the clock line to the microprocessor. The 74LS73 JK flip-flop is used to derive the Z80 clock signal from the video-display-generator clock output.

The Modulator and Display Generator

Note that the connections to the MC6847 are simple: the address lines (A0 thru A12) and data lines (D0 thru D7) go to the shared bus. At the bottom of the schematic, there are seven control lines that determine the display mode. These lines are controlled by one of the four I/O ports.

The MC6847 and MC1372 connect directly together. In this configuration, the MC1372 is wired to provide an RF output, so that Micrograph may be tied to the antenna leads of a television through a matching transformer. (See figure 4 for the wiring option to provide direct video output.)

Also tied to the modulator is the clock circuitry, which provides a 3.579545 MHz signal, which is the standard color-burst frequency. This clock is routed to both the video-display generator and the modulator.

The variable capacitor in the timing circuit is used to fine-tune the displayed colors. On the right side of figure 2 is the RF tank circuit, which can be tuned to station 3 or 4.



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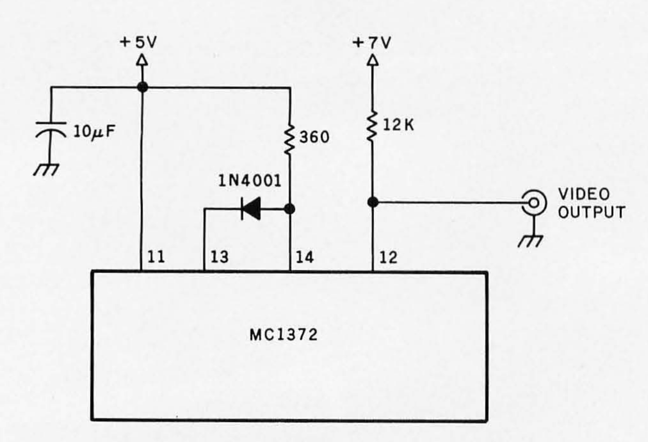


Figure 4: *Optional wiring for direct video output. The Motorola MC1372 can be used to provide direct (composite) video to a video monitor, if it is available. As shown in figure 2, the MC1372 may also be used to provide an RF (radio-frequency) output for use with television set tuned to channel 3 or channel 4.*

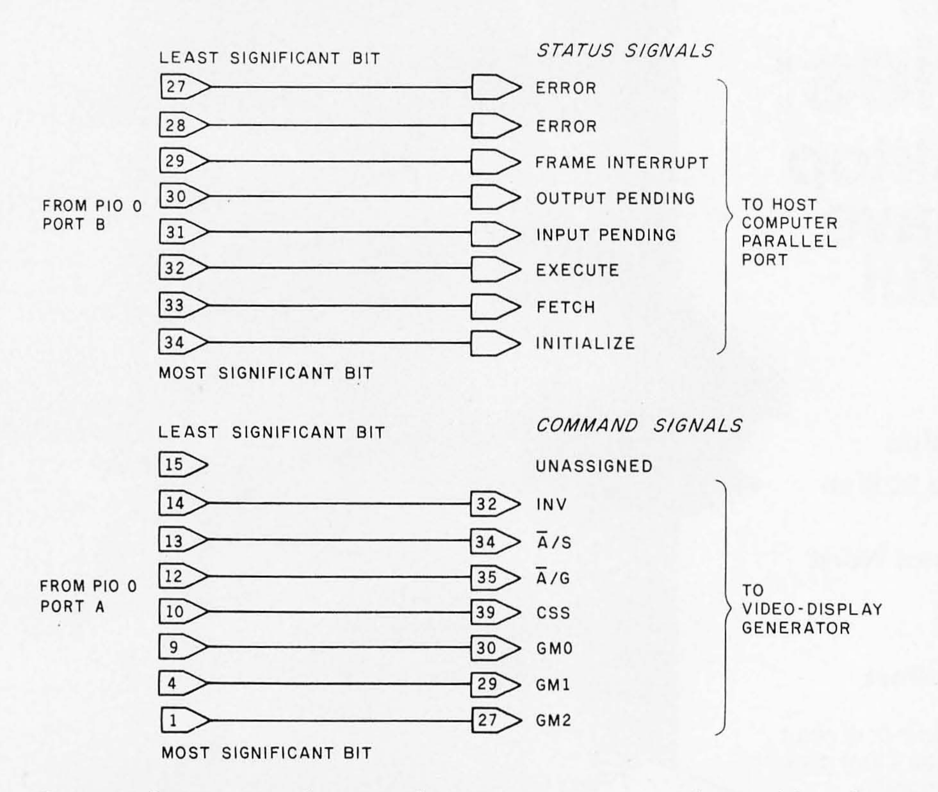


Figure 5: *Status-port and command-port pin assignments and control-byte formats. One PIO (peripheral input/output) port is used to communicate status information to the host processor and also to control the video-display generator. These connections must be added to figure 2.*

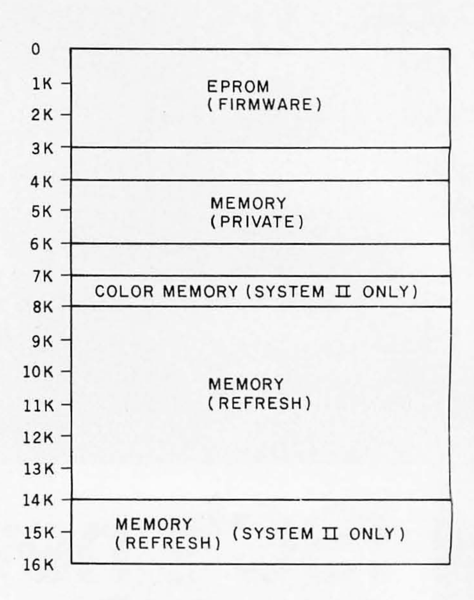


Figure 6: *Memory map for the Micrograph board.*

Bus Control

The address and control lines are routed to 74LS367 bus drivers, where they are then passed to the memory and I/O circuitry. The top four address lines are also routed to a 74LS154 four-to-sixteen-line decoder to provide memory chip-select decoding. Finally, the two 8216 bus drivers buffer the data lines. Their direction is controlled by the DBIN signal from the shared bus.

I/O Circuitry

Only two PIO (peripheral-input/output) circuits are needed. PIO 0 provides a status indication to the host through one port. (See figure 5 for the format of the status byte). The other PIO 0 port is routed to the video-display generator to select the proper display format. (Figure 5 also provides the format of this control byte.) The second PIO circuit is used to communicate with the host computer.

One of the ports is used to receive data and instructions from the host (the input port), and the other port is used to transmit data back to the host (the output port). In either case, the strobe lines for both of these ports are controlled by the host to indicate that Micrograph is being sent an instruction or that the host has just received a data byte. The protocol for communicating with the host computer will be further discussed in Part 3 of this article. Refer to tables 3 and 4 on page 132 for the port assignments in the microprocessor address space.

Firmware and Frame Buffer

Three 2708 EPROMs (erasable programmable read-only memories) are used to hold the 2.6 K bytes of the object code required to control Micrograph. Four type-2114 1024 by 4-bit static-memory devices provide the 2 K bytes needed by the firmware for variables and data for the programmable character generator. Refer to figure 6 for a memory map and to tables 3 and 4 for memory and port assignments.

In the frame buffer, 6 K bytes of memory are required, and 2114s are used to keep the device count low. Figure 6 provides the map for the frame-buffer memory also.

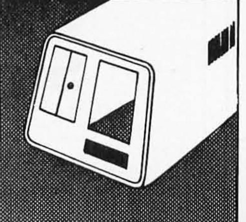
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DIPs (dual-in-line packages) and a handful of discrete components. Micrograph can be constructed on a single board and requires only a +5 V, +12 V, and −5 V power supply.

Construction

Photos 1a and 1b show my prototype Micrograph. I used a universal wirewrap board, and as the photo indicates, a spacious layout was possible as a result of the low device count. In the leftmost section of photo 1a are the Z80 and the two PIO devices. In the next section are part of the bus drivers and the EPROMs. In the middle section are the rest of the bus drivers and some of the 2114 memory circuits. In the next and final sections are the rest of the memory integrated circuits and the video-display circuitry. Note the few discrete components required: most are decou-

Type of memory	Address (decimal)
EPROM	0 to 3071
private memory	4096 to 6143
color memory 0	7168 to 7183
color memory 1	7184 to 7199
color memory 2	7200 to 7216
refresh memory	8192 to 14335 (for System I) 8192 to 16383 (for System II)

Table 3: *Type and location of memory used in the Micrograph board.*

Port Number	Device Name	Use	Type of Port
port 0	PIO 0, port A	display control	output
port 1	PIO 0, port A	port control	output
port 2	PIO 0, port B	status	output
port 3	PIO 0, port B	port control	output
port 4	PIO 1, port A	input	input
port 5	PIO 1, port A	port control	output
port 6	PIO 1, port B	output	output
port 7	PIO 1, port B	port control	output

Table 4: *Port numbers and their usage by Micrograph.*

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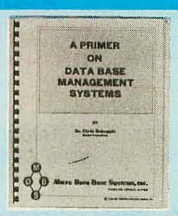
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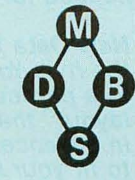


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pling capacitors. This physical layout follows the schematic layout almost exactly.

In photo 1b (page 136) is a view of the wirewrap side. It took me two weekends to wrap the board, using a Slit N' Wrap tool marketed by Vector and also an electric wirewrap tool. I used Slit N' Wrap techniques for the bus and, as best as I could, tried to color-code the whole device.

Any construction technology can be used to build this board, but there are a few hints I might pass along. To begin, insure that the video-modulator circuitry is well isolated from the rest of the system: keep the wiring as short as possible in this section. Furthermore, because of the relatively high frequencies used, be sure to minimize stray capacitance: a shielded board will help reduce interference.

Micrograph is best built in stages. I suggest you start with the video-display generator and modulator circuit. Wire this area first, then temporarily wire some memory on the 6847's bus. You can go ahead and supply power to this circuit to verify that your display is working properly. The various modes can then be tested. At this time, you can connect the modulator to your television (use coaxial cable, and don't forget a matching transformer). When you apply power, a random pattern that reflects the mode you have selected should appear. The variable capacitor in the timing circuit can then be adjusted to produce the most pleasing colors.

Once the video display is working properly, you should install the rest of the refresh memory and bus drivers. Again, repeat the checkout of the display, this time using all the refresh memory. Note that the 256 by 192 or 128 by 192 resolution modes will utilize all the memory. You might even connect an oscilloscope to the address lines to check that the lines are cycling through the entire 6 K bytes of memory.

Once this portion is working, the EPROMs, Z80, and PIOs can be wired in. From this point, there is little testing to do without the necessary software, which will be discussed in Part 3.

Troubleshooting a system without good tools is almost impossible. I found that I needed no more than a good oscilloscope to check out the system, even though I had a Hewlett-Packard 1611 Microprocessor Analyzer available. The Micrograph system has an excellent test device built in: the color display. Since the video-display generator scans all of the refresh memory, you have a visual means of checking a large portion of your wiring. To track down a bad memory circuit, you might selectively remove integrated circuits and watch how the display is affected.

One final word concerning the construction. The system draws +5 V at about 1.5 A, so don't make your power bus small. The other supplies, since they are mainly for the EPROMs, require only a few hundred milliamperes. When powering up the system, if your supplies are independent, be certain the −5 V supply powers up first and powers down last, if it can't be done simultaneously with the rest of the power. (I didn't do it that way and, consequently, destroyed six EPROMs; *then* I read an obscure warning in an Intel data book.)

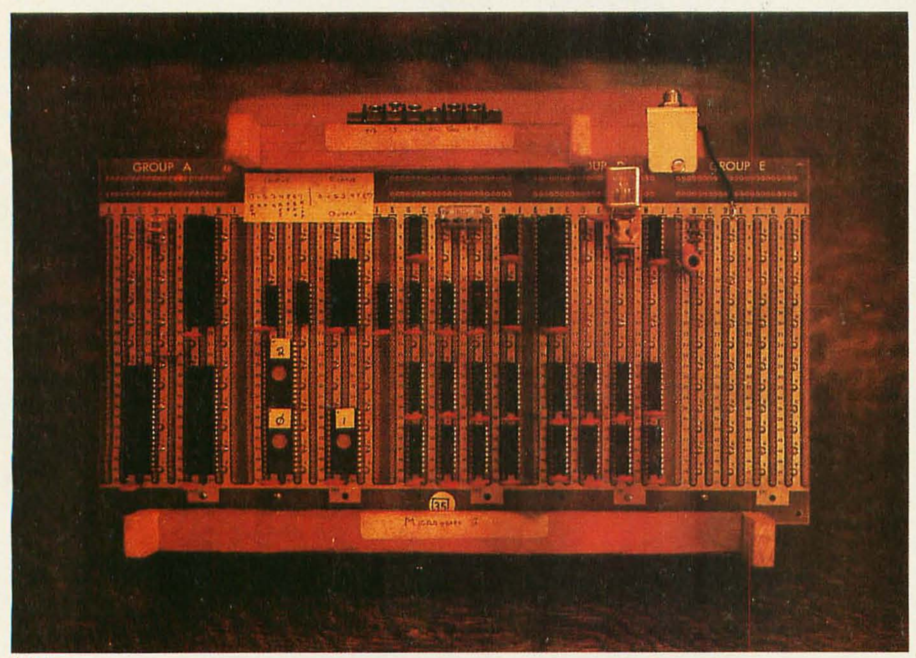
Enhancements: System II

There are a number of enhancements to the system that will increase the system performance, although I have not implemented them. The first obvious improvement is to use a Z80A (capable of using a 4 MHz clock) and run the system on the color-burst clock. This will immediately double the speed of the display processor. Of course, be sure that your memory is fast enough to handle the extra speed.

You might also try to use dynamic memory. I used static memory to reduce the development risk and make the design and testing of the board easier, but if the timing works out, the use of dynamic memory would significantly reduce the cost of the system.

These are some basic improvements that can be made, and I'll offer some more radical changes, which I call System II. When I first designed Micrograph, I created a system consisting of over 100 DIPs for the video section alone. This design supported two formats: 128 by 128 with sixteen colors and 256 by 256 with two colors. The system also supported a color-look-up table, to allow a set of 2^{12} (or 4096) possible

(1a)



(1b)

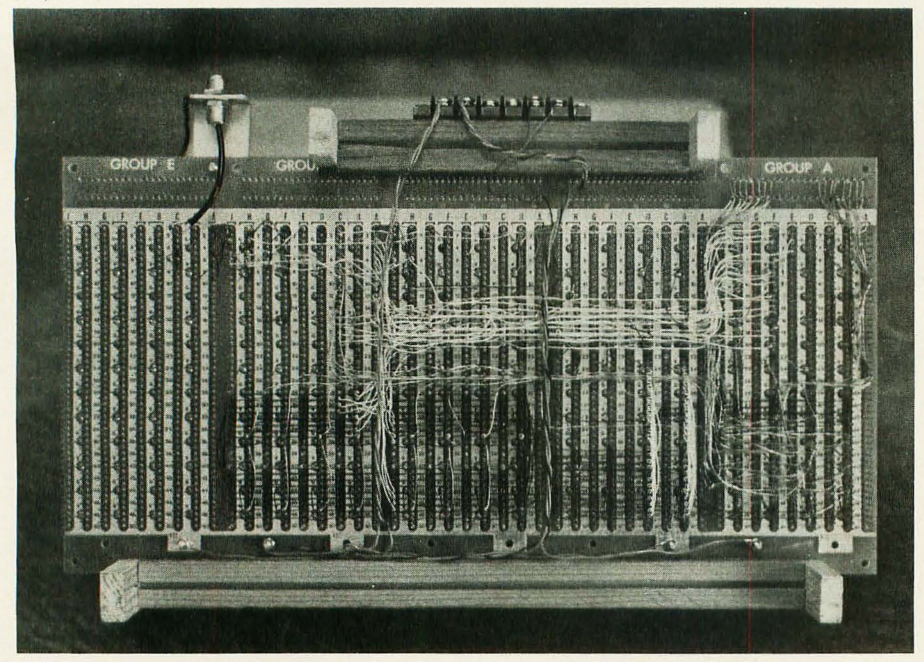


Photo 1: *Two views of the completed Micrograph prototype. The use of a universal wirewrap circuit board (photo 1a) allows a spacious layout that almost exactly follows the schematic diagram of figure 2. Photo 1b shows the wiring that required approximately two weekends of the author's time. A daisy-chaining wirewrap tool was used for the majority of the bus wiring, while control signals were made in the standard wirewrap fashion; power is provided to the integrated circuits via buses printed and etched on the board.*

colors. However, I came across the MC6847 and decided to use this lower-risk approach to complete the system, since my main concern was the software design and instruction set.

I designed the software so only one section of code must be altered to support the new display resolutions. The code already exists to support the color-look-up tables, but the MC6847 obviously does not have the capability to support such a setup. Thus, you only need to modify the video-display electronics and one section of code to produce System II. The remainder of the hardware and software remains the same, as does the interface between the host and Micrograph. Thus, in a sense, there is hardware independence built into the system.

For that matter, you can produce just about any display resolution up to 256 by 256 with 256 colors without major modifications to the circuitry other than the video-display generator. Of course, at these higher resolutions, you need much more memory. So, for the dedicated reader, I offer this as a possible system enhancement; it's something I'm going to try next. As you can see, the design of Micrograph using the MC6847 supplies an excellent color display at a very low price.

I offer a final radical change, but I haven't implemented it. In this design, we assume that the video display has the bus whenever it needs it. This scheme produces a clear, tear-free display. However, if the microprocessor is given priority for memory accesses, quality of display is traded for speed. In fact, in my approach, the Z80 is only allowed control of the bus around 20% of the available time. Of course, this is not a problem with a dedicated microprocessor.

If raw speed is necessary, however, let the microprocessor have dominant bus control, and give the bus to the video-display generator only when the software permits it (such as after the display has been updated). This approach has the advantage of having a much faster processing speed. However, it has the drawback of causing a streak across the screen whenever the microprocessor is updating the display. Furthermore, you will need to modify the software and hardware to accommodate this approach. By the way, a similar approach is used by Motorola's TVBUG, a 6802/6847-based board that allows the user's system to treat the refresh memory as an intelligent peripheral.

Conclusion

This article concludes the presentation of the hardware required to support Micrograph. I have examined the circuit design, discussed construction details, and looked at various system enhancements. Photos 2a and 2b provide some examples of displays possible with Micrograph.



Multi-User

UniFLEX is the first full capability multi-user operating system available for microprocessors. Designed for the 6809 and 68000, it offers its users a very friendly computing environment. After a user 'logs-in' with his user name and password, any of the system programs may be run at will. One user may run the text editor while another runs BASIC and still another runs the C compiler. Each user operates in his own system environment, unaware of other user activity. The total number of users is only restricted by the resources and efficiency of the hardware in use.



Multi-Tasking

UniFLEX is a true multi-tasking operating system. Not only may several users run different programs, but one user may run several programs at a time. For example, a compilation of one file could be initiated while simultaneously making changes to another file using the text editor. New tasks are generated in the system by the 'fork' operation. Tasks may be run in the background or 'locked' in main memory to assist critical response times. Inter-task communication is also supported through the 'pipe' mechanism.



Support

The design of UniFLEX, with its hierarchical file system and device independent I/O, allows the creation of a variety of complex support programs. There is currently a wide variety of software available and under development. Included in this list is a Text Processing System for word processing functions, BASIC interpreter and precompiler for general programming and educational use, native C and Pascal compilers for more advanced programming, sort/merge for business applications, and a variety of debug packages. The standard system includes a text editor, assembler, and about forty utility programs. UniFLEX for 6809 is sold with a single CPU license and one years maintenance for $450.00. Additional yearly maintenance is available for $100.00. OEM licenses are also available.

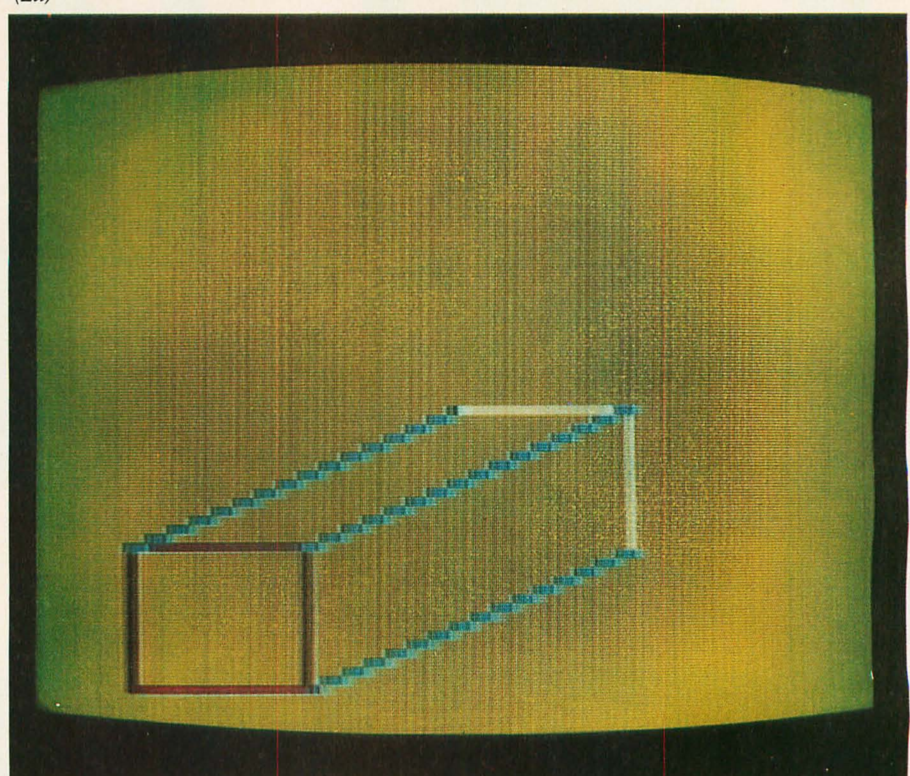
FLEX™

UniFLEX is offered for the advanced microprocessor systems. FLEX, the industry standard for 6800 and 6809 systems, is offered for smaller, single user systems. A full line of FLEX support software and OEM licenses are also available.



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(2a)



(2b)

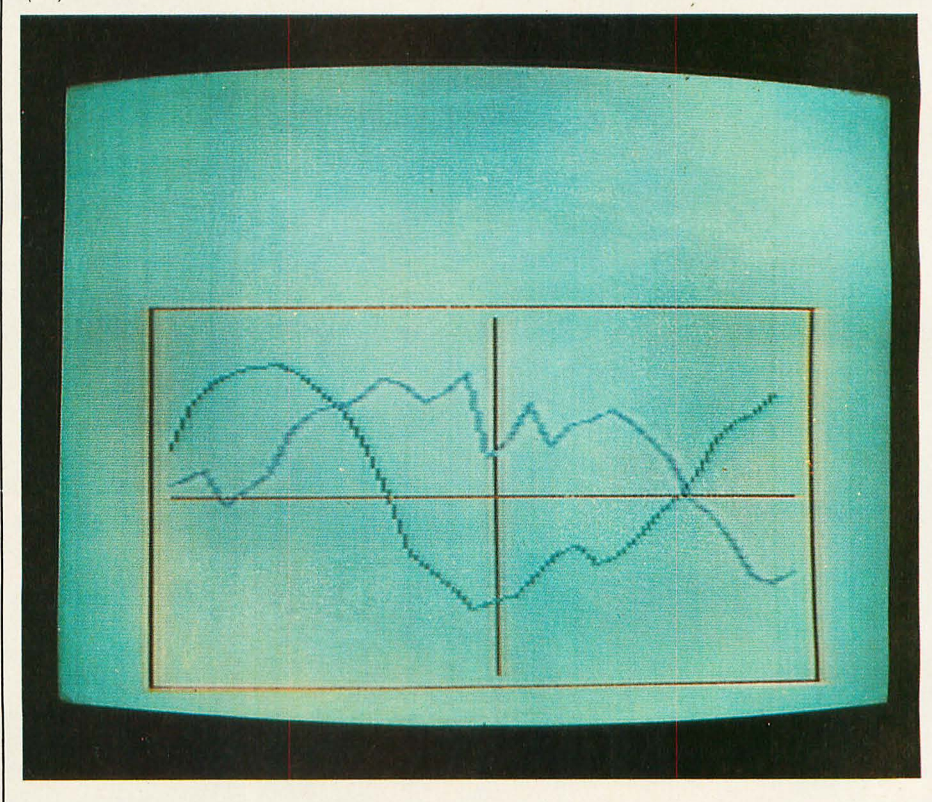


Photo 2: *Examples of Micrograph displays.*

Listing 1 contains the second third of the Micrograph software (begun in Part 1 and to be completed in Part 3). In the final part of this article, I will discuss the software needed by Micrograph to implement the instruction set presented in Part 1, cover the major algorithms implemented in the system (such as the scan-line-conversion algorithm), and examine how to operate Micrograph. ■

Listing 1 begins on page 327

DYNACOMP

Quality software for:

ATARI	**TRS-80 (Level II)**
PET	**NORTH STAR**
APPLE II Plus	**CP/M 8" Disk**

Availability

DYNACOMP software is supplied with complete documentation containing clear explanations and examples. All programs will run within 16K program memory space (ATARI requires 24K). Except where noted, programs are available on ATARI, PET, TRS-80 (Level II) and Apple (Applesoft) cassette and diskette as well as North Star single density (double density compatible) diskette. Additionally, most programs can be obtained on standard 8" CP/M floppy disks for systems running under MBASIC.

GAMES

BRIDGE 2.0 (Available for all computers) — **Price: $17.95 Cassette, $21.95 Diskette**

An all-inclusive version of this most popular of card games. This program both BIDS and PLAYS either contract or duplicate bridge. Depending on the contract, your computer opponents will either play the offense OR defense. If you bid too high, the computer will double your contract! BRIDGE 2.0 provides challenging entertainment for advanced players and is an excellent learning tool for the bridge novice.

HEARTS 1.5 (Available for all computers) — **Price: $14.95 Cassette, $18.95 Diskette**

An exciting and entertaining computer version of this popular card game. Hearts is a trick-oriented game in which the purpose is not to take any hearts or the queen of spades. Play against two computer opponents who are armed with hard-to-beat playing strategies.

CRIBBAGE 2.0 (TRS-80 only) — **Price: $14.95 Cassette, $18.95 Diskette**

This is a well-designed and nicely executed two-handed version of the classic card game, cribbage. It is an excellent program for the cribbage player in search of a worthy opponent as well as the beginner wishing to learn the game, in particular the scoring and jargon. The standard cribbage score board is continually shown at the top of the display (utilizing the TRS-80's graphics capabilities), with the cards shown underneath. The computer automatically scores and also announces the points using the traditional phrases.

CHESS MASTER (North Star and TRS-80 only) — **Price: $19.95 Cassette, $23.95 Diskette**

This complete and very powerful program provides five levels of play. It includes castling, en passant captures and the promotion of pawns. Additionally, the board may be preset before the start of play, permitting the examination of "book" plays. To maximize execution speed, the program is written in assembly language (by SOFTWARE SPECIALISTS of California). Full graphics are employed in the TRS-80 version, and two widths of alphanumeric display are provided to accommodate North Star users.

STARTREK 3.2 (Available for all computers) — **Price: $ 9.95 Cassette, $13.95 Diskette**

This is the classic Startrek simulation, but with several new features. For example, the Klingons now shoot at the Enterprise without warning while also attacking starbases in other quadrants. The Klingons also attack with both light and heavy cruisers and move when shot at! The situation is hectic when the Enterprise is besieged by three heavy cruisers and a starbase S.O.S. is received! The Klingons get even!

SPACE TILT (Apple only) — **Price: $10.95 Cassette, $14.95 Diskette**

Use the game paddles to tilt the plane of the TV screen to "roll" a ball into a hole in the screen. Sound simple? Not when the hole gets smaller and smaller! A built-in timer allows you to measure your skill against others in this habit-forming action game.

GAMES PACK I and GAMES PACK II — **Price: $ 9.95 each, Cassette, $13.95 each, Diskette**

GAMES PACK I contains BLACKJACK, LUNAR LANDER, CRAPS, HORSERACE, SWITCH and more. GAMES PACK II includes CRAZY EIGHTS, JOTTO, ACEY-DUCEY, LIFE, WUMPUS and others. Available for all computers.

Why pay $5.95 or more per program when you can buy a DYNACOMP collection for just $9.95?

STUD POKER (ATARI only) — **Price: $11.95 Cassette, $15.95 Diskette**

This is the classic gambler's card game. The computer deals the cards one at a time and you (and the computer) bet on what you see. The computer does not cheat and *usually* bets the odds. However, it sometimes bluffs! Also included is a five card draw poker betting practice program. This package will run on a 16K ATARI.

STATISTICS and ENGINEERING

DATA SMOOTHER (Available for all computers) — **Price: $14.95 Cassette, $18.95 Diskette**

This special data smoothing program may be used to rapidly derive useful information from noisy business and engineering data which are equally spaced. The software features choice in degree and range of fit, as well as smoothed first and second derivative calculation. Also included is automatic plotting of the input data and smoothed results.

FOURIER ANALYZER (Available for all computers) — **Price: $14.95 Cassette, $18.95 Diskette**

Use this program to examine the frequency spectra of limited duration signals. The program features automatic scaling and plotting of the input data and results. Practical applications include the analysis of complicated patterns in such fields as electronics, communications and business.

TFA (Transfer Function Analyzer) — **Price: $19.95 Cassette, $23.95 Diskette**

This is a special software package which may be used to evaluate the transfer functions of systems such as hi-fi amplifiers and filters by examining their response to pulsed inputs. TFA is a major modification of FOURIER ANALYZER and contains an engineering-oriented decibel versus log-frequency plot as well as data editing features. Whereas FOURIER ANALYZER is designed for educational and scientific use, TFA is an engineering tool. Available for all computers.

FOURIER ANALYZER and TFA may be purchased together for a combined price of $29.95 (Cassettes) and $37.95 (Diskettes).

REGRESSION I (Available for all computers) — **Price: $19.95 Cassette, $23.95 Diskette**

REGRESSION I is a unique and exceptionally versatile one-dimensional least squares "polynomial" curve fitting program. Features include very high accuracy; an automatic degree determination option; an extensive internal library of fitting functions; data editing; automatic data and curve plotting; a statistical analysis (e.g., standard deviation, correlation coefficient, etc.) and much more. In addition, new fits may be tried without reentering the data. REGRESSION I is certainly the cornerstone program in any data analysis software library.

REGRESSION II (PARAFIT) (Available for all computers) — **Price: $19.95 Cassette, $23.95 Diskette**

PARAFIT is designed to handle those cases in which the parameters are imbedded (possibly nonlinearly) in the fitting function. The user simply inserts the functional form, including the parameters (A(1), A(2), etc.) as one or more BASIC statement lines. Data and results may be manipulated and plotted as with REGRESSION I. Use REGRESSION I for polynomial fitting, and PARAFIT for those complicated functions.

REGRESSION I and II may be purchased together for $36.95 (cassettes) and $44.95 (diskettes).

BUSINESS and UTILITIES

MAIL LIST II (North Star only) — **Price: $21.95**

This many-featured program now includes full alphabetic and zip code sorting as well as file merging. Entries can be retrieved by user-defined code, client name or Zip Code. The printout format allows the use of standard size address labels. Each diskette can store more than 1100 entries (single density; over 2200 with double density systems)!

TEXT EDITOR I (Letter Writer) — **Price: $14.95 Cassette, $18.95 Diskette**

An easy to use, line-oriented text editor which provides variable line widths and simple paragraph indexing. This text editor is ideally suited for composing letters and is quite capable of handling much larger jobs. Available for all computers.

FINDIT (North Star only) — **Price: $19.95**

This is a three-in-one program which maintains information accessible by keywords of three types: Personal (e.g., last name), Commercial (eg: plumbers) and Reference (eg: magazine articles, record albums, etc). In addition to keyword searches, there are birthday, anniversary and appointment searches for the personal records and appointment searches for the commercial records. Reference records are accessed by a single keyword or by cross-referencing two or three keywords.

DFILE (North Star only) — **Price: $19.95**

This handy program allows North Star users to maintain a specialized data base of all files and programs in the stack of disks which invariably accumulates. DFILE is easy to set up and use. It will organize your disks to provide efficient locating of the desired file or program.

COMPARE (North Star only) — **Price: $12.95**

COMPARE is a single disk utility software package which compares two BASIC programs and displays the file sizes of the programs in bytes, the lengths in terms of the number of statement lines, and the line numbers at which various listed differences occur. COMPARE permits the user to examine versions of his software to verify which are the more current, and to clearly identify the changes made during development.

COMPRESS (North Star only) — **Price: $12.95**

COMPRESS is a single-disk utility program which removes all unnecessary spaces and (optionally) REMark statements from North Star BASIC programs. The source file is processed one line at a time, thus permitting very large programs to be compressed using only a small amount of computer memory. File compressions of 20-50% are commonly achieved.

GRAFIX (TRS-80 only) — **Price: $12.95 Cassette, $16.95 Diskette**

This unique program allows you to easily create graphics directly from the keyboard. You "draw" your figure using the program's extensive cursor controls. Once the figure is made, it is automatically appended to your BASIC program as a string variable. Draw a "happy face", call it H$ and then print it from your program using PRINT H$! This is a very easy way to create and save graphics.

TIDY (TRS-80 only) — **Price: $10.95 Cassette, $14.95 Diskette**

TIDY is an assembly language program which allows you to renumber the lines in your BASIC programs. TIDY also removes unnecessary spaces and REMark statements. The result is a compacted BASIC program which uses much less memory space and executes significantly faster. Once loaded, TIDY remains in memory; you may load any number of BASIC programs without having to reload TIDY!

SIMULATIONS and EDUCATION

BLACK HOLE (Apple only) — **Price: $14.95 Cassette, $18.95 Diskette**

This is an exciting graphical simulation of the problems involved in closely observing a black hole with a space probe. The object is to enter and maintain, for a prescribed time, an orbit close to a small black hole. This is to be achieved without coming so near the anomaly that the tidal stress destroys the probe. Control of the craft is realistically simulated using side jets for rotation and main thrusters for acceleration. This program employs Hi-Res graphics and is educational as well as challenging.

VALDEZ (Available for all computers) — **Price: $14.95 Cassette, $18.95 Diskette**

A simulation of supertanker navigation in the Prince William Sound and Valdez Narrows. The program uses an extensive 256X256 element radar map and employs physical models of ship response and tidal patterns. Chart your own course through ship and iceberg traffic. Any standard terminal may be used for display.

FLIGHT SIMULATOR (Available for all computers) — **Price: $17.95 Cassette, $21.95 Diskette**

A realistic and extensive mathematical simulation of take-off, flight and landing. The program utilizes aerodynamic equations and the characteristics of a real airfoil. You can practice instrument approaches and navigation using radials and compass headings. The more advanced flyer can also perform loops, half-rolls and similar aerobatic maneuvers.

TEACHER'S PET I (Available for all computers) — **Price: $ 9.95 Cassette, $13.95 Diskette**

This is the first of DYNACOMP's educational packages. Primarily intended for pre-school to grade 3, TEACHER'S PET provides the young student with counting practice, letter-word recognition and three levels of math skill exercises.

Ordering Information

All orders are processed and shipped postpaid within 48 hours. Please enclose payment with order along with computer information. If paying by VISA or Master Card, include all numbers on card. For orders outside North America add 10% for shipping and handling.

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Circle 91 on inquiry card.

A Simplified Theory of Video Graphics

Part 2

Allen Watson III
1261 Robbia Ct
Sunnyvale CA 94087

Color Television

To produce color television displays we need a picture tube with a phosphor screen that can be made to glow in different colors. This is done by a method similar to the half-tone method of color printing; a full-color picture is made by superimposing three single-color images made up of very small dots. At the normal viewing distance the dots are too small for the human eye to resolve, so that the colors appear to merge into a single image. The inside of a color television screen is covered with an array of small dots of three different phosphors that glow in red, green, a blue when struck by electrons. By carefully controlling the brightness of each colored dot we can produce any color we desire. (See text box, "The Primary Colors".)

The major problem is independent color control. We need three separate electron beams (ie: one for each color) arranged so one beam strikes only the red phosphor dots, one beam strikes the green dots, and one beam strikes the blue dots. It is not practical to aim the beams this precisely; instead, a *shadow mask* is used. The shadow mask is a perforated metal plate placed just behind the phosphor screen in the picture tube. The three electron beams can strike the phosphor dots only after passing through holes in the mask. The electron guns that produce the beams are positioned so each beam strikes only dots of the correct color; thus each gun casts an electron "shadow" on phosphors of the other colors. Brightness of each of the primary colors is controlled by the intensity of the corresponding electron beam.

Color by Direct Drive

A straightforward approach to color computer displays uses three identical video-refresh circuits, each with its own refresh memory, in order to generate separate signals for the three electron guns. This approach is relatively expensive; it takes three times as much refresh memory as an equivalent black-and-white display. If this method were used with the 200 by 300 dot display example discussed in Part 1 of this article, 3 × 7500 = 22,500 bytes of refresh memory would be required.

We can have a more economical system using direct drive of the three colors, but using only one refresh memory. (Some switching circuitry is necessary to display two colors instead of black and white.) With a special-character graphics system, we can use a few of our extra character codes to select the colors. The color displayed in place of white is called the *foreground* color and the one displayed instead of black is called the *background.* By inserting color-select characters wherever they are needed, it is possible to make different parts of the display show different colors. If each of the electron guns is either on or off, the colors available with this system will be the eight possible combinations of the three primary colors:

1. no color, or black
2. red
3. green
4. blue
5. red + green = yellow
6. green + blue = cyan
7. blue + red = magenta
8. all three = white

The main drawback to the use of direct drive (often referred to as *R-G-B*) is the cost of the color monitor. Professional monitors with separate red, green, and blue video inputs are not mass-produced, so they are quite expensive. Compucolor, the only personal computer manufacturer using direct-drive color, builds a low-cost

Note that the numbers used for figures, photos, and tables in this article have been continued from Part 1, which appeared in the November 1980 BYTE, page 180.



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The Primary Colors

In grammar school, most of us were taught that there are three primary colors (red, yellow, and blue) and that any other color can be produced by mixing these three. You may be wondering how color television manages to use red, green, *and blue as its primary colors. First of all, the primary colors we learned in school are appropriate only for pigments such as paints and crayons; light sources such as the glowing phosphor dots in a color picture tube don't work the same way.*

The creation of a color by mixing pigments relies on the subtraction (or partial absorption) of colors from the light falling on the pigment. If you mix pigments without adding white, the image gets darker. However, creating a color by mixing light works by addition, *so if you combine several colors of light, the result is lighter.*

Complementary *colors are essentially opposites: if you mix complementary-colored pigments the resulting color is black, but if you mix complementary-colored beams of light, the resulting color is white. This "symmetry" means that primary colors for light will be the complements of primary colors for pigments.*

This still sounds paradoxical: how can red, green, and blue be the complements of red, yellow, and blue? This apparent problem is caused by the vagueness of our color names. The colors in the two sets of primaries are actually all different, but one color in each set is reddish and one is bluish. You can see examples of the pigment primaries by examining a printed reproduction of a color photograph in which the printing plates are out of register. Here you can perceive the colors of the inks and that the "red" ink is actually red-violet, or magenta, *and that the "blue" ink is blue-green, or* cyan.

To see the primary colors used in television, try viewing a color test pattern by tuning to a television station before it is broadcasting programs. If you adjust your television set's color controls so the primaries are as pure as possible, you will find the green slightly yellowish, the red a bit orangy, and the blue almost indigo. If we arbitrarily use our vague color names for specific colors and call the television primaries red, green, *and* blue, *we must call the pigment primaries* magenta, yellow, *and* cyan *to avoid confusion. The two sets of primary colors make up complementary pairs, like this:*

Lights	Pigments
red	cyan
green	magenta
blue	yellow

color monitor into the computer in order to keep the total system cost reasonably low.

Color by Subcarrier

Another method of avoiding a high-priced color monitor is to use an ordinary color television set to display computer video. Even with the addition of extra circuitry needed to pick up broadcasts, home television sets cost less than professional monitors. However, there are drawbacks to the use of a television set.

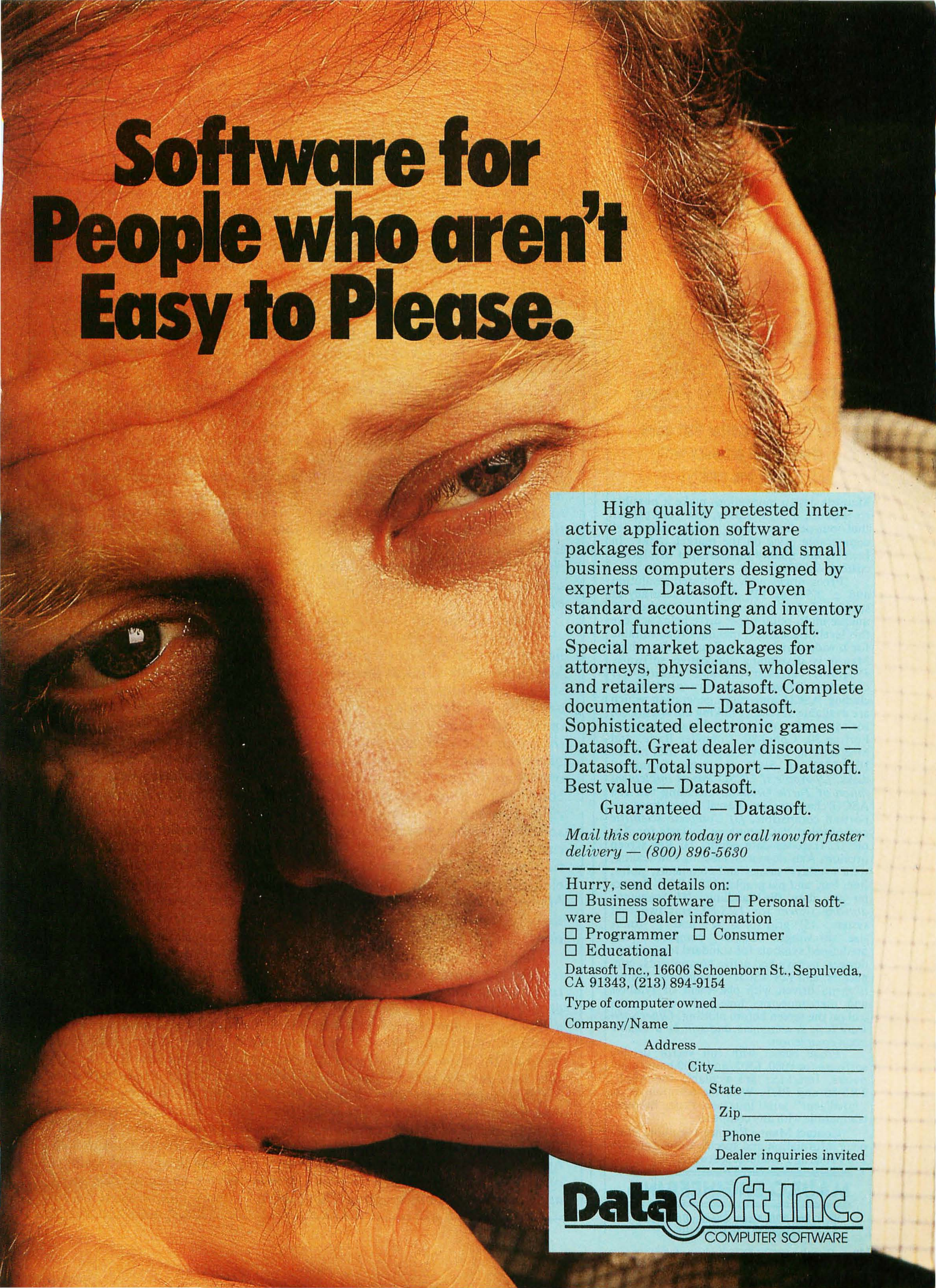
A color television set is designed to accept a VHF (very-high-frequency) radio signal or carrier that is modulated by a composite-video signal. This signal consists of horizontal and vertical synchronizing pulses, black-and-white picture information (called *luminance*), and a 3.58 MHz *subcarrier* that contains the color information (called *chrominance*). The subcarrier is modulated by the color information in such a way that the amplitude of the 3.58 HMz signal determines the intensity of the color at each point in the picture; the phase of the signal determines the actual color displayed. (Refer to the text box, "Outline of NTSC Color Standards.")

Remember that the video signal developed from memory produces output pulses at the appropriate times during the raster-scanning process. This creates dots of light on the display screen. It is convenient to design computer video circuits so each dot corresponds to a half cycle of the 3.58 MHz color subcarrier. If several dots are adjacent, the output will be a continuous high-level signal; this will appear on the screen as a white line as wide as the number of dots. If we alternate dots and spaces, the signal will consist of alternating high and low levels, each a half cycle wide, creating a square wave at the 3.58 MHz subcarrier frequency. The television set decodes the amplitude of the 3.58 MHz component of the composite video as the intensity of the color to be displayed, so what was sent out as a string of dots and spaces will be displayed as a brightly colored solid line.

The color that is displayed depends on the *phase* of the color subcarrier. The timing of the dots generated by the video-refresh circuits determines their phase. For example, with dots corresponding to half cycles, interchanging dots and spaces is equivalent to a phase reversal, or a 180° phase shift, which will produce the complement of the first color. To produce more colors, we must make smaller changes in the timing of the dots. The half-cycle dots are produced by computer circuits running at twice the color subcarrier frequency, or 7.16 MHz. If we make our circuits run twice as fast (14.3 MHz), we can put dots on quarter-cycle intervals and have 90° phase differences. With the half-cycle dots this would give us four colors in addition to black and white.

Bit mapping is not the only way to produce NTSC (National Television System Committee) color signals. Our computer can have circuits that work like character generators, to decode different values of refresh data into appropriate dot patterns, for even more colors. The circuits can produce dots a quarter-cycle long, separated by spaces three-quarters of a cycle long and vice versa, which are still at the frequency of 3.58 MHz. The quarter-cycle dots can be at any of four phases, as can the three-quarter cycle dots, giving us eight more colors for a total of twelve, plus black and white. The quarter-dot colors will have a low average voltage level and, hence, lower brightness when compared to the longer three-quarter cycle dots. In other words, four of the twelve colors produced by this technique will be dark, four will be medium bright, and the re-

Text continued on page 150


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Outline of the NTSC Color Standards

In 1953 the NTSC (National Television System Committee) announced a method of color television broadcasting that was adopted as the US standard. The NTSC system superimposes color picture information onto the older black-and-white signal in such a way that the resulting composite signal is compatible with the old standards. This means that color broadcasts may be viewed on black-and-white sets (and vice versa), and this made it possible to continue using black-and-white equipment.

A color television camera is essentially a combination of three monochrome (ie: black-and-white) cameras, each viewing the same scene through a different colored filter. The most straightforward way to transmit color television into the home would be to send these three signals over the air, but that would require the equivalent of three television channels and would not be economically feasible.

Studies of human vision have shown that fine details in color are not resolved as well as they are in black-and-white. This is fortunate since it allows transmission of color picture information with a much narrower bandwidth than three separate channels would require. In order to take advantage of this effect, the NTSC technique converts the three signals from a color camera into one full-resolution black-and-white signal called the luminance *signal, and two color-difference signals called* chrominance *signals (which are filtered to limit their bandwidth, thereby decreasing their resolution).*

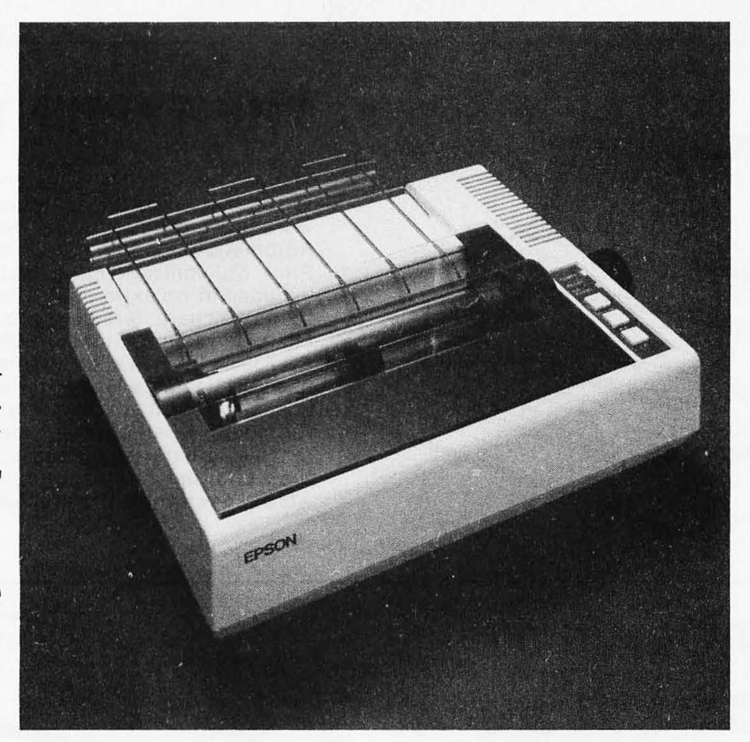
The total bandwidth required for the luminance signal plus the two chrominance signals is about 40% greater than the bandwidth of a black-and-white signal, still too broad to keep within the 4.5 MHz bandwidth that was originally allocated for the video signal. The NTSC system puts the chrominance signals into the band that is already occupied by the luminance signal. This trick is accomplished by putting the chrominance signals onto a subcarrier, *which is then added to the luminance signal. The subcarrier is so called because, while it modulates the radio-frequency carrier along with the normal video signal, it is also a carrier.*

The subcarrier frequency must be higher than that of the information it is to carry, although there is a maximum frequency that will still fit within the 4.5 MHz bandwidth. Another reason for putting the subcarrier at a relatively high frequency is that the luminance signal has less energy at higher frequencies, so there is less interference between the luminance and the subcarrier. There are still more complex aspects of the NTSC technique required to minimize this interference and to preserve certain other characteristics of the original black-and-white television signal, but their importance in computer applications is not great enough to warrant a full description here. The net result is that the horizontal line frequency is changed slightly in the NTSC system, to 15,734.26 Hz, and the color subcarrier is put at 3.579545 MHz. This is usually referred to as the 3.58 MHz color subcarrier.

The two chrominance signals modulate the 3.58 MHz subcarrier together in such a way that the resulting signal has an intensity or amplitude proportional to the amount of color at each point in the picture and a phase that determines the particular color. There must be a standard phase for the receiving set to refer to in decoding the color information, so a short burst of unmodulated 3.58 MHz subcarrier is transmitted during part of each horizontal retrace interval. This so-called color burst *is used by the receiver to generate a reference subcarrier phase.*

It turns out that most television sets don't do a very good job of separating the chrominance and luminance signals that are combined so cleverly in the NTSC system. Compromises made in the interests of lower cost cause most sets to lose the fine detail in the picture and pick it up as chrominance instead. This means that fine vertical black-and-white stripes will sometimes produce spurious colors on the screen. You can see this effect by watching for colored streaks across those striped shirts worn by news announcers.

If you just bought another printer, boy are you gonna be sorry.



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The Epson MX-80. It's not just another worked-over rehash of last year's model. It's our top-of-the-line 80-column printer. It's new. From the ground up. And it's the most revolutionary printer to hit the market since Epson invented small printers for the 1964 Olympics in Tokyo. Don't take our word for it, though. Compare. There simply isn't a better value in an 80-column printer. Period.

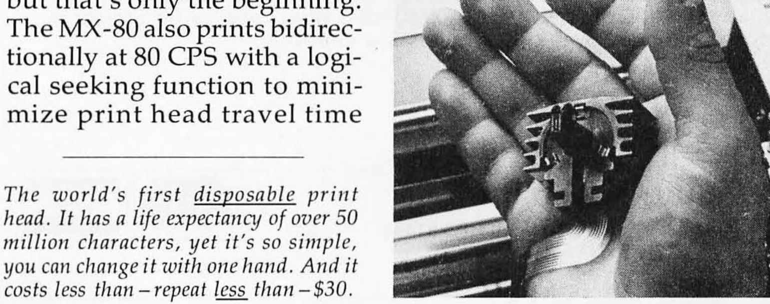
But here's the fact that's going to stand the printer world on its ear. The MX-80 sports the world's first *disposable* print head. After it's printed about 50 million characters, you can throw it away. Because a new one costs less than $30, and the only tool you need to change it is attached to the end of your arm.

Now that's revolutionary, but that's only the beginning. The MX-80 also prints bidirectionally at 80 CPS with a logical seeking function to minimize print head travel time and maximize throughput. It prints 96 ASCII, 64 graphic and eight international characters in a tack-sharp 9x9 matrix. And it provides a user-defined choice of 40, 80, 66 or 132 columns and multiple type fonts.

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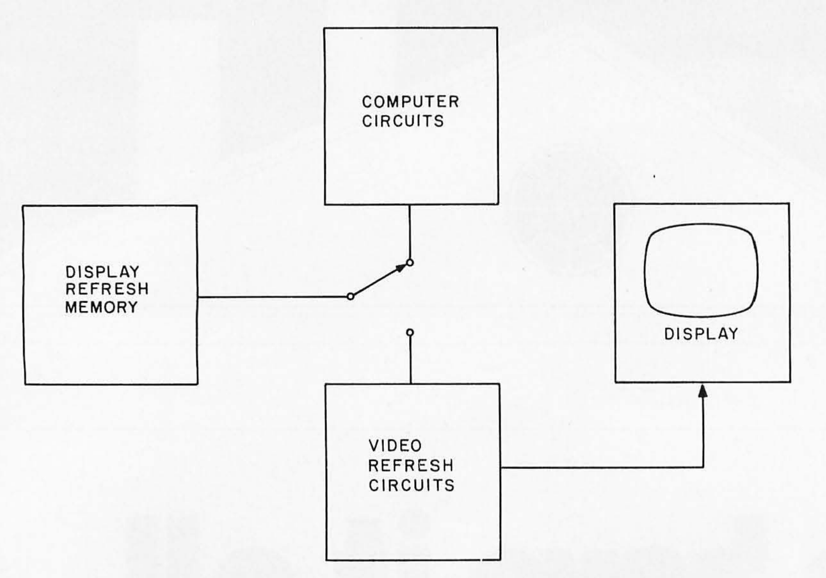


Figure 2: *The cause of video-display dropouts. Several popular microprocessor systems use a display scheme that switches the refresh memory out of the video-refresh circuitry whenever some refresh memory location is changed. This is interpreted by the display as a blank line on the screen for a short interval.*

Text continued from page 144:
maining four will be pastels. (See photo 2 on page 152.)

This method of color production has some drawbacks. For one thing, it produces spurious black or white margins wherever certain color areas touch. This is due to the behavior of the dot patterns. If the dot pattern for green is binary 0101 and the pattern for magenta is 1010, you can see that there will be either two dots together or two spaces together whenever a green area is next to a magenta one. Two or more dots together produce white on the display.

Another problem arises when trying to superimpose text and color. Since the characters are made of lines only one dot wide, some parts of the characters will match the dot patterns of the colors and they will disappear if displayed on a colored background. One way to avoid this is to make characters of elements at least two dots wide. This prevents their merging into colored backgrounds, but at a price: you cannot fit as many of these wider characters into the display.

Undocumented Features and Quirks

Several of the personal computers listed in Part 1 of this article have subtle quirks that are not apparent at first glance and are never mentioned in the manufacturers' specifications or sales literature. While they could easily escape your notice during a demonstration at the computer store, they could become very irritating once you become aware of them. If you are planning to use one of these computers for graphics, you should be aware of these quirks before you decide which computer to buy. Although you may discover other problems, these are the major design flaws in the personal computers listed:

- asymmetrical plotting
- video-refresh dropouts
- limited color resolution
- adjacent color interactions

Asymmetrical Plotting

Asymmetrical plotting makes a plot with the same number of dots horizontally and vertically come out not as a square but as a rectangle. Some personal computers are quite bad in this respect while others produce almost perfectly symmetrical plots. You can figure whether or not a display is symmetrical by finding the ratio of its horizontal resolution to its vertical resolution, and comparing the result with the *aspect ratio* of the display portion of the screen. The aspect ratio is the display width compared with the display height: a standard television screen is a third wider than it is high, so its aspect ratio is 4:3. If a computer's display is symmetric, the number of dots it takes to fill the screen in each direction will be proportional to the size of the screen in that direction. You will probably

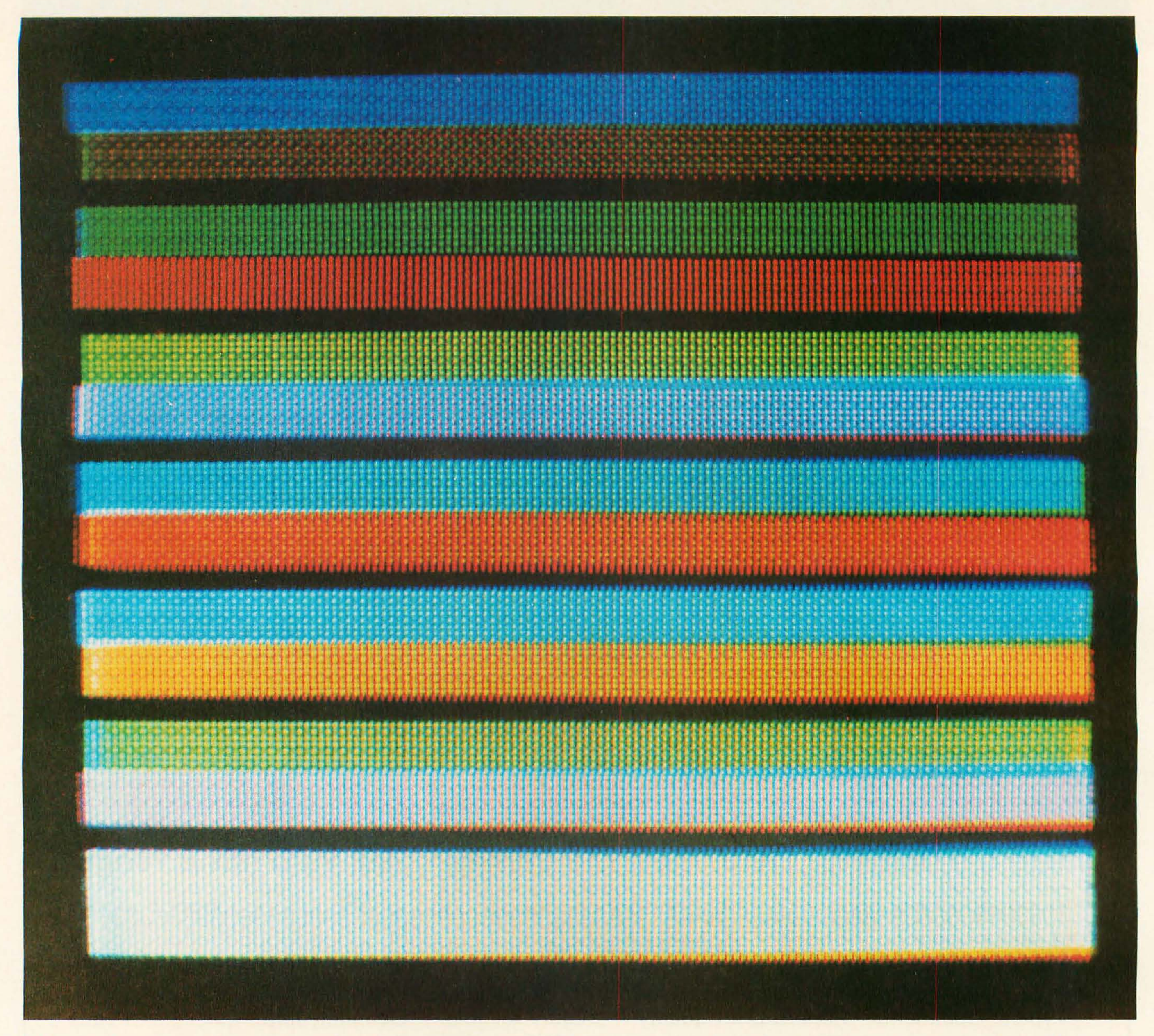


Photo 2: *Bars of complementary colors. Twelve colors (plus white) can be produced by the color-subcarrier method, where each cycle of the 3.58 MHz color frequency is broken into quarters. By varying the phase and by putting out signals with a duty cycle of 75%, 50%, or 25%, a computer display can select the color.*

be able to program the computer to compensate for an asymmetric display, but the results may look so ragged that you prefer to live with the asymmetry.

Video-Refresh Dropouts

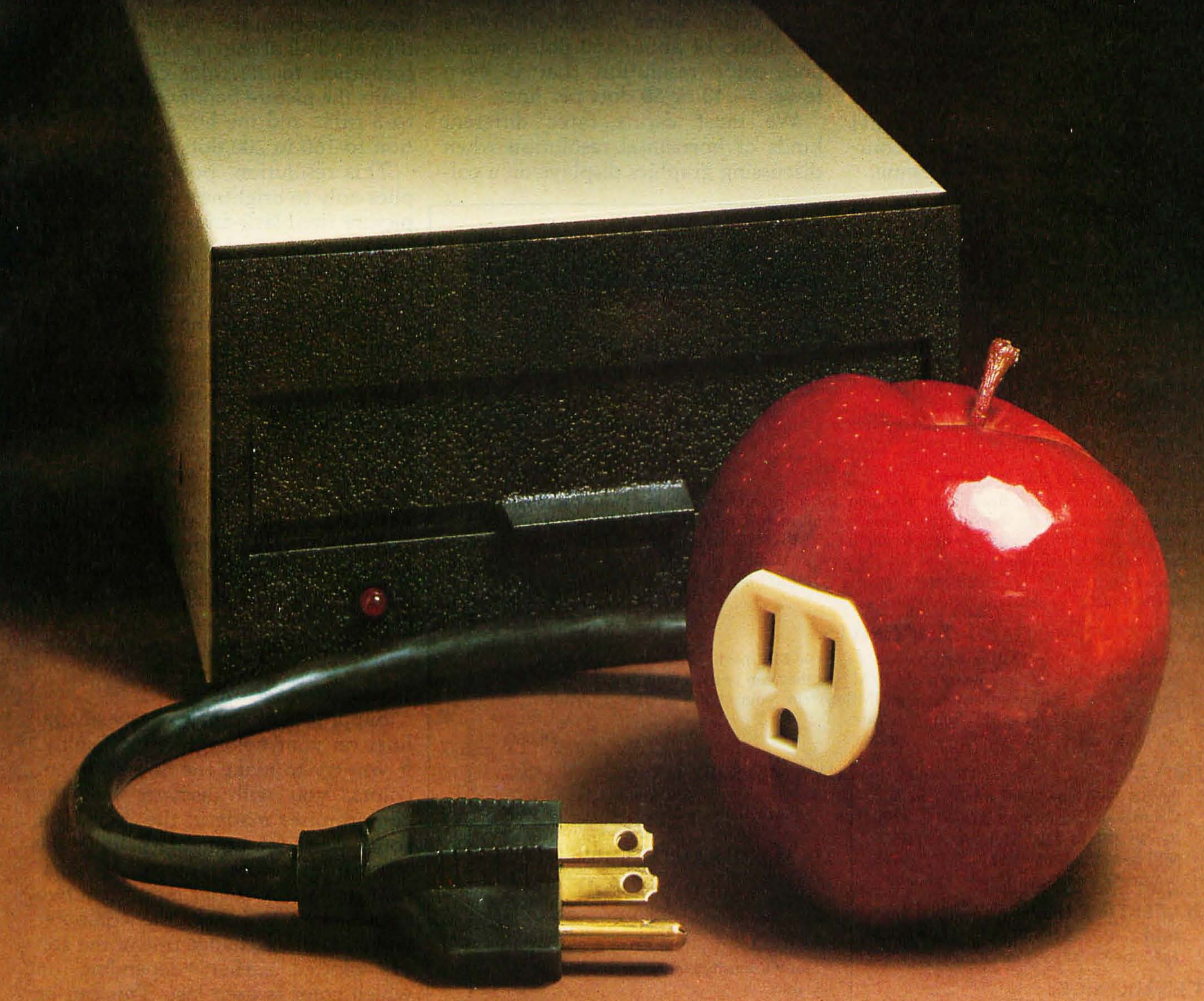
Video-refresh dropouts look something like the interference produced by static from electric motors and automobile ignitions (ie: short, horizontal black lines that appear very briefly and in random locations on the screen.) They are not external interference in this case, but are self-inflicted. Whenever a Radio Shack TRS-80 or an Exidy Sorcerer accesses the video-refresh memory (either to read it or to change it), the computer interrupts the video refresh. (See figure 2.) The severity of the resulting display-data dropouts depends partly on the nature of the data being displayed. If only text is being displayed, with a black background, most of the dropouts will occur in areas of the screen that are already black and pass unnoticed. (The small-keyboard Commodore PET has dropouts too, but they are white and only appear when the display is PEEKed or POKEd.)

Dropouts happen only while the data in the computer's video-refresh memory is being read or changed; if the display is being changed often, as during animation, the occurrence of dropouts will increase. So if you are planning to use your computer for animated graphics, look for models that do not have this problem.

In order to avoid having video dropouts, some personal computers have refresh memory that runs twice as fast as necessary for refreshing the display. This makes it fast enough to respond to a memory-access request by the computer between two successive transfers to the display. The computer and the display share the refresh memory by taking alternate memory cycles. Neither interferes with the other in any way.

The main reason that all personal

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The Model A-70, on the other hand, features twice the tracks and capacity of the Apple Disk II, but it costs only a few dollars more.

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computers do not use this method of preventing dropouts is cost. The components for this refresh memory must be capable of operating at twice the normal speed—this makes the memory more expensive. Or looking at it another way, without the need for fast refreshing, the higher-speed memory would enable us to use a faster microprocessor and obtain better performance. Another factor affecting the design of the refresh memory is the type of microprocessor being used; some types have internal clocking schemes that are not compatible with this refreshing scheme.

Limited Color Resolution

If you choose a computer that generates NTSC video in order to use an ordinary color television set for your display, you may be disappointed by the poor horizontal resolution. Even though the computer produces a signal with up to 280 dots per horizontal line, the television set will only show black-and-white resolution of about 160 dots per line and color resolution that is even lower — 40 or 50 dots per line.

We must define three different kinds of horizontal resolution when discussing graphics displays on a color television receiver. To start with, you can distinguish the 280 dot positions even on a color set. (We might call this figure the *accuracy* of the display, since it determines the smallest difference that the computer can display.) The resolution problem arises due to the way most color television sets separate the color information from the rest of the video: they send all of the high-frequency information to the color circuits. This limits the picture bandwidth to only 2 to 3 MHz and the horizontal resolution to 160 to 200 dots per line.

This resolution, poor as it is, applies only to brightness changes in the picture (ie: black-and-white information). If you display different colors next to each other, the colors will smear across the width of four or five dots. This is due to the narrow bandwidth of the color circuits. A bandwidth of about half a megahertz allows only about fifty color changes across the width of the screen. In spite of this, you can produce quite good displays on a color television set by using a lot of black and white along with colors. Most of the picture consists of brightness differences and has horizontal resolution of about 160 dots per line. Displaying black between different colored areas keeps the color smears from being visible.

Color Interactions

Suppose you want to draw several lines on your color-graphics display. If you try to make the lines different colors, you will discover that the compromises made in the designs of some personal computers limit the number of colors that can be adjacent. If you try to put more than two colors close together, the computer will sometimes change one of the colors plotted earlier, depending on which color is used last. This can be rather disconcerting the first time it happens to you and worse when you find that it is a characteristic of your computer. You may be able to minimize the effect it has on your displays by understanding the mechanism behind it in order to "program around it."

This problem arises in the Compucolor II and in the Texas Instruments TI-99/4 because of their background-foreground schemes for specifying colors. Programs on these machines can use any one of the available colors for the dots being displayed (ie: the foreground) and any other color for the background. Each character cell can have its own

foreground and background colors, so the colors can be different in different parts of the display. However, inside a region that is the size of a character, there can be only two colors. If you try to draw a colored line through a cell that already has two other colors in it, the foreground points in that cell will be displayed as the new color.

The Apple II has a similar problem due to the tricky way it selects colors in high-resolution mode. High-resolution graphics on the early Apple II have only two colors, plus black and white. It uses bit mapping of 7 bits out of each displayed byte. Later models have been modified to use the eighth bit in each byte to select two more colors by shifting the phase of the dots made by the other 7 bits. This means that the color-select bit in each byte determines which two colors are available for seven adjacent points. If a line happens to fall in the same seven-dot-wide region as one already plotted, with the color-select bit the other way, the color-select bit will get changed to match the new line. (See table 2.)

Model	Apple II	Compucolor II	TI-99/4
region height	1	4	8
region width	7	2	8
colors in region	4	2	2
colors available	6	8	16

Table 2: *The color interaction characteristics of three popular microprocessor systems. The four colors in a seven-dot region on the Apple II are black, white, and one of the pairs: green and magenta or orange and blue. Any character-cell region in the Compucolor and Texas Instruments computers can have any two of the available colors, with black and white counted as colors.*

Which Method Is Best?

By now it shouldn't be surprising that I don't single out one personal computer as *the best.* It should also be obvious that my criticism of particular features of certain manufacturers' computers does not automatically disqualify them or imply that their competitors' machines are superior. Careful examination of newer computers is likely to reveal other peculiar features.

My explanations of these undocumented quirks are intended to show how published specifications fail to provide complete descriptions of these machines. The different approaches to graphics displays may result in similar specifications, but the displays may perform quite differently in a particular application. You should try to understand these differences so you can evaluate them in terms of your own needs and make your own judgments.

The most important graphics feature of a personal computer is simply having graphics. Of course, you *can* produce video displays that are adequate for some applications on a system that does not have any graphics features. For example, photo 3 shows a plot of a histogram produced by means of standard characters. Most of the ubiquitous *Star Trek* games also use this approach, which might be called *pseudographics.* Still, such displays are limited both in information content and in visual appeal.

The personal computers I have mentioned all have at least some kind of block-graphics display. Photo 3 and photo 4 show the same histogram

displayed using pseudographics and low-resolution block graphics.

The next important feature of a graphics display is color. If you doubt the validity of that statement, ask yourself why, when television made the transition from black and white to color, all the commercials were done in color long before all the programs were. Statistically speaking, you could say that a color display can convey three times as much information as a black-and-white display with comparable resolution. This generalization fails to describe the impact that color provides. If your objective in having graphics on your computer is to enhance the effectiveness of your displays, then you are almost certain to find that color capability is worth the cost.

Photo 3: *Pseudographics are created by using characters that are meant for viewing as standard text.*

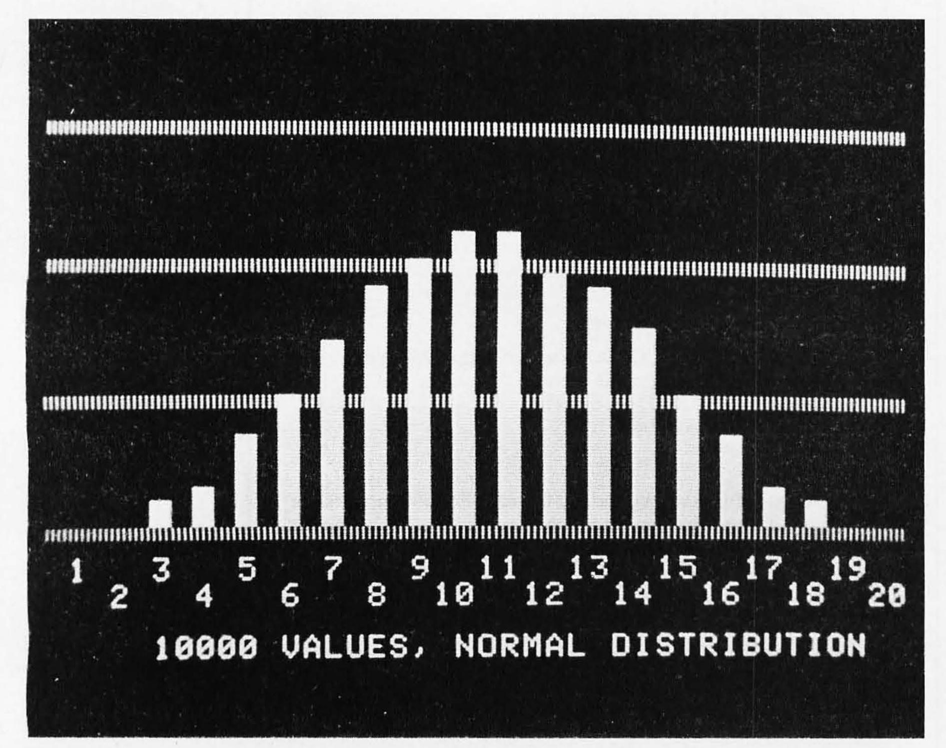


Photo 4: *The same histogram shown in photo 3 is repeated here using subcell-block graphics on a 40 by 40 grid.*

Next we come to the question of resolution, and here things get a little complicated. An inexpensive way to get high resolution is by means of special characters, but this method is not well suited for producing graphs of curves or other mathematical functions. You can directly compare the specifications of the other types of graphics systems, subcell and mapping, because these enable you to plot a curve as a series of *points in ordinary rectangular coordinates*. The higher the resolution, the smoother and more accurate these plots will be.

However, special-character graphics systems do not allow you to plot arbitrary curves in high resolution. Only predetermined shapes can be displayed, except on the Texas Instruments and Exidy machines with their programmable graphics characters. While it should be possible to write a program to dissect a curve into 8 by 8 graphics cells on these computers, it would be extremely tedious. This means that the resolution of a special-character system is not directly comparable with that of the other types. How important that is to you depends on your need to plot curves with your computer. It also demonstrates another way that specifications can be misleading if you look only at the numbers.

I hope that the information I have provided has not given you the idea that the graphics displays on all the current personal computers are unusable. I think it is very exciting that we can get so much graphics capability on such inexpensive machines. My objective in presenting this description has been to help you see the reasons behind their differences. If you can understand them, you will be able to figure out which type is most appropriate for making the kind of graphics displays you are interested in.■

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On the Road to Adventure

Bob Liddil
The Programmer's Guild
POB 66
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Adventure! The very word brings forth visions of high intrigue and danger. The armchair adventures of the personal computer user can be every bit as exciting as the real thing, without the personal risk.

Adventure players are just as dedicated to their activity as are any of the many different types of gaming enthusiasts. They expect a high standard of excellence.

This article by no means claims to cover all there is to know about Adventure. [*The capitalized word Adventure will be used to refer to this class of games as a whole . . . .*GW] What I will do is introduce the reader to the styles and procedures that have popularized Adventure to almost cult status and present the currently popular authors along with their works. Additionally, there will be tips on how to play Adventure without tearing your hair out and going totally crazy.

What Is Adventure?

Adventure is a semi-intelligent, word-recognizing computer program that employs a narrative style to present an unsolved puzzle. (For an example of an Adventure dialog, see listing 1.) The format of the game can be almost any organized grouping of locations that are bound together by a single theme. The clues to the puzzle are tied to the theme so that the game flows logically and smoothly. Solving the puzzle in whole or part leads to the treasure or to valuable clues to the ultimate winning of the game. Some Adventures are goal oriented, while others rely on the accumulation of valuable objects.

The commands in Adventure affect four factors: where you are, what you see, where you can go, and what you can do.

Magic words are popular with some Adventure authors.

Your puppet, the narrator inside the program who resides in the world of your Adventure, can freely use the data provided by the computer to deliver your options to you. When you respond, the puppet executes your command and lives (or dies) through the consequences.

By paying careful attention to the information given you through the faculties of your puppet, you can move him freely through his environment. One mistake can cost you the game (and the puppet his life).

How to Play Adventure

Your puppet will do whatever you command if it is within his power. He is totally dependent on you for his sequence of action. He understands quite a vocabulary of two-word English sentences, but you must be careful because he takes your commands *literally*. Thus, a command to a puppet standing at the edge of a cliff to JUMP will cause the puppet to hurl himself into space, resulting in (depending on the author) consequences ranging from death to soft landing. A command of SHOOT HORSE in a western Adventure could leave you afoot.

GO, GET, LIFT, CARRY, PUSH, KICK, SHOOT, ATTACK, KILL, FEED, LEAD, and DRINK are only a few of the many (usually more than one hundred) direct-action commands available to the player of Adventure. One Adventure by Scott Adams has a fully functional bathroom with a presumably anatomically correct puppet responding to the direct-action command USE !

EXAMINE always gets results, even when the response is a seemingly nonhelpful, I SEE NOTHING SPECIAL. This is still a clue in that it eliminates the object just examined from further consideration. Sometimes EXAMINE reveals something that you have overlooked. In a recent outer-space scenario, I carried a phaser pistol for almost an hour before remembering to examine it. When I did, I discovered that it had two settings, stun and destroy. I had been stumped, but now I destroyed a certain object and things fell logically into place. I was able to proceed with the game, following it to an entertaining and pleasant conclusion.

Movement commands are usually simplistic. In some Adventures, possible directions to take are displayed at the top of the screen with the title "OBVIOUS EXITS ARE:". These may not be your only options, however. Lost in a desert, with a road in sight (and the message YOU SEE: A ROAD, CACTUS, SAND displayed), you may have the additional movement-command options of GO ROAD, GO CACTUS, or GO SAND. These may produce such diverse results as YOU ARE ON A ROAD, YOU SEE: DESERT, MOUNTAINS, TOWN or OUCH ! I'M STUCK FULL OF PRICKLY PEAR NEEDLES or I'VE BEEN BITTEN BY A RATTLESNAKE, I'M DEAD.

About the Author

Bob Liddil is a freelance writer and is both game designer and president of The Programmer's Guild. He is interested in photography and noncomputer fantasy war-gaming, and his equipment includes a Radio Shack TRS-80 Model I computer with 48 K bytes of memory, two MPI disk drives, and a Centronics 730 printer.

Listing 1: *Sample dialog from an Adventure. These three screens are from* Lost Dutchman's Gold, *an Adventure from The Programmer's Guild. The questions and long replies are by the Adventure program. The two-word replies at the end of each indented line are the player's command. Although the format will vary from Adventure to Adventure, each one will tell you something about your immediate surroundings. In this Adventure, the information above the heavy lines is rewritten after each command. In other words, the legend DEAD BURDENBEAST at the top of the last screen is displayed only after the command SHOOT BURDENBEAST (at the bottom of the screen) is given.*

```
YOU ARE IN A SMALL CAMP.  YOU SEE :
CARRYSACKS. UNTIED BURDENBEAST. LEATHER PIECE. CAMPFIRE.

OBVIOUS EXITS ARE : WEST NORTH SOUTH EAST
==============================================================

          WHAT DO YOU WANT TO DO NOW? GET BURDENBEAST
? YOU HAVE NOT THE STRENGTH TO DO THAT, SIR KNIGHT.
          WHAT DO YOU WANT TO DO NOW? EXAMINE CAMPFIRE
THERE'S SOMETHIN' HERE !!
          WHAT DO YOU WANT TO DO NOW? EXAMINE BURDENBEAST
YOU SEE A FLOP-EARED ILL TEMPERED QUADRAPEDAL ANIMAL.
          WHAT DO YOU WANT TO DO NOW? DROP CARRYSACKS
OK
--------------------------------------------------------------
YOU ARE IN A SMALL CAMP.  YOU SEE :
UNTIED BURDENBEAST. LEATHER PIECE. CAMPFIRE.

OBVIOUS EXITS ARE : WEST NORTH SOUTH EAST
==============================================================

          WHAT DO YOU WANT TO DO NOW? EXAMINE CARRYSACKS
IT IS A WELL WORN DOUBLE CARRYSACK
IT APPEARS  TO HAVE SOMETHING IN IT,
MAYBE YOU SHOULD GET IT.
          WHAT DO YOU WANT TO DO NOW? GET CARRYSACKS
OK
          WHAT DO YOU WANT TO DO NOW? OPEN CARRYSACK
OK
--------------------------------------------------------------
YOU ARE IN A SMALL CAMP.  YOU SEE :
DEAD BURDENBEAST. LEATHER PIECE. CAMPFIRE.

OBVIOUS EXITS ARE : WEST NORTH SOUTH EAST
==============================================================

MAYBE THE BURDENBEAST HASN'T BEEN FED RECENTLY
          WHAT DO YOU WANT TO DO NOW? FEED BURDENBEAST
YOU'RE TOO SLOW, HE GOT AWAY.
          WHAT DO YOU WANT TO DO NOW? GET HANDWEAPON
OK
          WHAT DO YOU WANT TO DO NOW? SHOOT BURDENBEAST
WITH WHAT? HANDWEAPON
OK
```

Not that you shouldn't try all available options—there could just as easily be a treasure or a clue behind that cactus or in that underbrush. Things can often be examined from a distance. If not, a curt YOU CAN'T DO THAT YET will appear on the screen, followed by a nasty electronic snicker from deep within your computer. Generally, when the word YET appears in a message, you know you are on the right track.

Magic words or teleportation phrases are popular with some Adventure authors. SAY the magic word and the whole world spins around, taking you elsewhere or elsewhen. This is a convenient way to travel, but it can be a two-edged sword that might land your puppet in never-never land for an indefinite stay. There are at least two Adventures in which teleportation phrases are employed (with pitfalls in both). A third accepts an incantation from another Adventure; however, the response is instant death.

CLIMB is a word you can use to get somewhere when saying a magic word does not teleport you. If you are carrying an object, you may have to drop it to proceed with climbing. Generally, what can be climbed into can be climbed out of. Don't be afraid

to go into tight places; they can provide clues to your game.

Logic is your best friend in playing Adventure. Approach a situation with a careful eye for detail. Going into a room and drinking from a bottle without examining it (using the words GO, DRINK, and EXAMINE) can result in your puppet being poisoned. In real life you would never imbibe without looking at a label; why kill off your puppet needlessly? The same reasoning applies to any phase of your Adventure. Apply common sense and you will win every time.

On the other hand, the author of your Adventure, while bound by the laws of order and fair play, is not above puns, a little chicanery, or out-and-out silliness. Watch for double meanings in the author's choice of words; he will fool you, if he can, with painfully obvious clues.

The HELP, SCORE, and INVENTORY commands are always explained in the openings of the programs. They accomplish what their names imply.

Adventures are tremendous fun, but you must stay alert and ask the right questions: What do I see? Where can I go? What is the easiest way to get there? What can I do where I am? These questions can help you solve the puzzle and win the game.

There are six main vendors of microcomputer-based Adventures: Scott Adams, Greg Hassett, Radio Shack, The Programmer's Guild, Microsoft, and Mad Hatter Software. The following sections give a synopsis (revealing none of the secrets, however) of their product lines at the time of this writing.

Scott Adams Adventures

Twenty-eight-year-old Scott Adams is generally credited with being the father of microcomputer Adventures. The game began as a "head toy" for the PDP-10 and other large computers. Through Scott Adams and his company, Adventure International, it soon found its way into the 16 K-byte TRS-80 heartland of America. Here is a list of his Adventures:

- *Adventureland* is a lighthearted little trip into the countryside. This first effort was written in BASIC, then changed to machine language. It is a good beginning point for the novice since it is not too complicated. There are a bog and a lake and numerous other natural features to keep things lively. This is an Adventure that uses a magic word.
- *Pirate's Cove* is rated as a classic. Its smooth storytelling style quickly sets the standard for all Adventures to follow. There are four basic locations: a flat in London, an island, a Treasure Island, and never-neverland. The wild and wacky characters that populate this game only enhance it. A pirate, a mongoose, a parrot, and assorted other beasties give this Adventure a delightfully humorous effect.
- *Mystery Fun House* is an excursion into the madcap world of a carnival funhouse. It includes passing a gatekeeper and exploring multiple corridors. You must find a variety of objects within the funhouse and get out within the time limit. This one is a real brain teaser.
- *Mission: Impossible* pits you against unknown enemies in a race to stop a nuclear reactor from being destroyed. To complicate matters, there is a bomb planted in your head. This one is pretty tough to solve and is an absolute must for those whose Adventure skills have become well honed.
- *Strange Odyssey* is one of the best of this series. You are alone on a strange planetoid with only a broken spaceship and your wits. There is a rock with alien runes on it. If you solve the mystery of gaining entrance, a stargate to brave new worlds with treasures awaits you. Manipulation of objects with alien environments plays an important role in the solution of this puzzle.
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Rev non-zero console	1.4	170/25 *
iCOM 3812	1.4	170/25 *
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*Software consists of the operating system, text editor, assembler, debugger and other utilities for file management and system maintenance. Complete set of Digital Research's documentation and additional implementation notes included. Systems marked * and ** include firmware on 2708 and 2716. Systems marked + include 5440 media charge. Systems marked Ⓜ require the special Ⓜ versions of software in this catalog. ◇ includes hardware addition to allow our standard versions of software to run under it.*

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MICRO FOCUS

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EIDOS SYSTEMS

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☐ **BASIC UTILITY DISK**—Consists of: (1) Ⓜ CRUNCH-14—Compacting utility to reduce the size and increase the speed of programs in Microsoft BASIC 4.51, BASIC-80 and TRS-80 BASIC. (2) DPFUN—Double precision subroutines for computing nineteen transcendental functions including square root, natural log, log base 10, sine, arc sine, hyperbolic sine, hyperbolic arc sine, etc. Furnished in source on diskette and documentation .... $50/$35

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Speed is the essential difference between machine-language and BASIC Adventures.

hallways and darkened dungeons of Voodoo Castle. There is a juju man, a *kachina* doll (a likeness of the Count), a book for removing curses, and much more. For entertainment value, this one rates very high.

- *Pyramid of Doom* takes you to an unexplored pyramid somewhere in Egypt. You have the key and can begin the search for a treasure under the watchful eyes of an ever-present nomad. This one is so good that after two weeks, I *still* haven't solved even a portion of it . . . yet.
- *Ghost Town* is an Adventure with a Western theme that has all the mystique of a John Wayne epic. The puzzle is one of the most rewarding and entertaining of Scott's nine Adventures. The maze is an authentic ghost town complete with saloon, hotel, jail, boot hill and an outrageous piano-playing ghost. This one is great fun.

Greg Hassett's Adventures

Of note to Adventure shoppers are the differences between the machine-language versions of Adventure and BASIC-language versions. The latter are appearing on the market in ever-increasing numbers. *Speed* is the essential difference. To most players of Adventures, the difference in execution time is of little importance. To the Adventure cultist, however, speed is everything. With this in mind, the authors who write Adventures in BASIC, ever in the shadow of Scott Adams and his beginnings in BASIC, are one by one graduating to machine language, blinking cursors, and (blinding) speed. One such author is Greg Hassett.

Greg is a 13-year-old schoolboy from Chelmsford, Massachusetts. His eye for detail and wry writing style have placed his Adventures in direct comparison with those of Scott Adams. This is unfortunate for two reasons. Greg's work is often judged unseen and dismissed due to his age or the fact that most of his programming has been in BASIC. When critiqued on their own merit, however, the Hassett Adventures stand up well in both entertainment and value per dollar.

- *Journey to the Center of the Earth* is a perky little trip into the interior of our planet. The earthdigger in which you are riding gets a busted Gonkulator, and you have to find a new one (or something to replace it with) somewhere in the maze of tunnels in which you find yourself. Giant bugs and treasure make this beginner's game interesting.
- *House of the Seven Gables* pits you against a wicked witch in a haunted house. More complicated than its predecessor, this program will be deadly to those who take its puzzle lightly. Unique objects of value and scenes of personal combat give a player his money's worth with this one.
- *Atlantis:* If undersea is where you want to be, this one is for you. Personal combat is taken one step further with the guardians of treasures being fierce sea creatures. The entire Adventure is done under water, and it's a lot of fun. Whirlpools and octopi and denizens of the deep await you here.
- *Sorcerer's Castle* allows you to challenge the evil sorcerer on his own turf. Well, if you can find your way out of the woods, you'll be just in time to fight and may even confront the evil sorcerer personally. Treasure abounds here, with ample puzzlement to please even the most demanding Adventure enthusiast.
- In *Enchanted Island,* magic and mystery join hands to present an Adventure of worth. The highly different flavor of this program would be spoiled by the presentation of any details in this review. It is the author's most challenging Adventure written in BASIC.
- *Enchanted Island Plus:* Like Scott Adams, Greg Hassett also quests for the increased speed offered by a machine-language Adventure. This program has it all—speed, blinking cursor, and an increased number of locations. This Adventure is a must buy.
- *Mystery Mansion* summons you in a dream to come solve the mystery of a haunted mansion. Good pace and colorful descriptions are the selling points for this Adventure. It is a fast, well-written machine-language Adventure, and it should especially appeal to younger Adventure fans.
- *World's Edge* gives you a future where the Earth's pollution count has finally reached a critical level. You can save the planet from extinction

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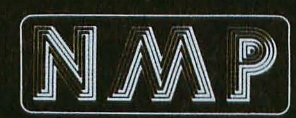
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with 2.2 kg of APC-80 located on a small distant planetoid. However, the element is considered holy by the inhabitants of the planetoid, so a fight is imminent . . . . This is by far the most imaginative plot from Greg, who seems to love to add combat to his Adventures. It is also another of his machine-language Adventures.

Radio Shack Adventures

- *Pyramid 2000*, the first Adventure from Radio Shack, is a machine-language scenario set in Egypt. You explore the pyramid for gold and glory without the scrolling or blinking cursor that hallmarks other microcomputer Adventures. Still, the authors have managed to work a much-used theme to its maximum, drawing a fairly complex and entertaining puzzle.

- *Haunted House*, like its cousin *Death Dreadnaught*, deals not with gold or glory, but survival. Once inside the house, you are pitted against unseen enemies with awesome telekinetic powers. Levitating knives and eerie occurrences await the Adventurer here. Produced for Tandy Corporation by Device Oriented Games of Dallas, this is an excellent offering.

The Microsoft Adventure

Microsoft Consumer Products, a sibling company to the Microsoft that has written so many versions of BASIC, has a very heavy version of Adventure available on disk only (most Adventures are supplied on cassette tape). It is reputed to be a copy of the original Adventure written by Crowther and Woods for the Digital Equipment Corporation PDP-10. The original Colossal Cave is there, and there is ample room on the floppy disk for the over 400 eloquent descriptions.

The Programmer's Guild Adventures

One of the newest of the Adventure publishers is a little company called The Programmer's Guild. It distributes three adventures written by independent authors. *Lost Dutchman's Gold* and *Spider Mountain* are by Teri Li, and *Death Dreadnought* was coauthored by Biff and Spudd Mutt [*pseudonyms, I hope . . . .*GW] of Device Oriented Games.

- *Lost Dutchman's Gold* is a Western Adventure. In the Superstition Mountains of Arizona, you accompany the ghost of Backpack Sam, a grizzled old former prospector, who knows the secret of the Lost Dutchman's mine. There are Indians, a stubborn mule, a ghost town, and the Superstitions, dark and mysterious, to keep you spellbound throughout the simulation.
- *Spider Mountain Adventure* is a classic *Dungeons and Dragons* type Adventure that employs Shelob, a giant spider, as guardian of the many treasures of Spider Mountain. Armed with only a crossbow, you face orcs and spiders in the maze of tunnels under the mountain.
- *Death Dreadnought*, rated R by its own publisher due to extreme descriptions of violence, pits man against an unseen horror that has devastated an entire alien battlecruiser. As the last living human on board, the Adventurer is required merely to escape. This, however, is no small task with a killer on your trail and an unsolved maze before you. This one is not for the squeamish or faint of heart.

Mad Hatter Adventures

Mad Hatter Software, which began as a distributor for the Hassett Adventures, recently launched two titles of its own.

- *Sleuth* is a detective story, a whodunnit Adventure with graphics and sound. The graphics consist of video maps of where you are, and the sounds are the primitive tink-boop sounds that characterize early sound effects for the TRS-80.
- *Quest* uses the same graphics and sound techniques as *Sleuth* but is more of a fantasy Adventure. Neither held my attention the way the other Adventures reviewed did. Plotlines are thin and seem to be built around gimmickry rather than solid plots and programming.

How to Write an Adventure

Adventures are, first and foremost, puzzles. You (the Adventure author) must be prepared to satisfy the Adventurer's lust for the unsolvable, while at the same time making it easy enough for the novice.

Choose a recognizable theme. In *Spider Mountain*, for example, it is evident that the Mountain is the goal.


Whatever happened to eenie, meenie, miney, mo?
...a perfect gift for that urban cowgirl!
Maybe this'll help me choose a career...
I could use it to select my staff.
Should I buy stock or commodities in this economy?
I could be another Solomon...
This may put the Godfather out of business.
If only my heart would stop racing...
It must use Bayesian, weighted factor analysis, and...
Brilliant! Like a window into the future.
Would I rather have Winston's millions or Billy Joe's love?
Hmmmm... could be my ticket to the Boardroom.
Can't any of these people afford $29.95?
The decision is...
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So, as the game begins, we leave the campsite, hiking as fast as we can for the mountains we see in the distance. An hour or so of looking for a way to find the treasure *on* the mountains soon convinces us that the goal must be *inside* or possibly *under* the mountains. In fact, the author has sidetracked us away from the *real* entrance to Spider Mountain, but this is OK as long as it is enjoyable and related to the rest of the Adventure.

Clues and equipment may be scattered throughout the theme area. Their locations should not be obvious to avoid easiness, but they should also not be impossible to find. Avoid highly complicated situations; they interrupt the flow of your game.

Several minor or subtheme areas will spice up the game. It is not necessary to provide a lot of memory-consuming action in the lesser areas; however, nobody likes an empty room (desert, etc), so at least put something there for your player's trouble.

Scott Adams' use of subtheme areas in *Strange Odyssey* is one of the best examples of this concept. By breaking his Adventure up into different worlds, each with its own complications and dangers, Scott effectively entertains his audience without frustrating them. Some of the differences among the stargate worlds of this Adventure are deadly, but not to the point of aggravation.

Make sure that your overall theme does not duplicate an Adventure already in existence. Both Adams and Hassett have extensive lines of Adventure scenarios. Mad Hatter Software and The Programmer's Guild, which have only a few Adventures each, are both planning more.

Research your settings. Make sure that your locations ring of authenticity and that your descriptions are accurate; otherwise, your reader will spend more time criticizing than playing.

Be certain that your Adventure has a large enough vocabulary to function well. If you add radical words to your vocabulary, be sure that provisions are made for giving clues about them to your player.

Be innovative. Don't wait around for someone else to do it. Introduce new features into your game. Make *your* Adventure unique in the marketplace.

Above all, *be entertaining*. Your audience will come back for more and more if you give them their money's worth each and every time they play.

Adventure is the product of imagination appealing to imagination. It is not just the puzzle, or the theme, or the nonplayer characters and their personalities. It is a verbal tapestry of interwoven phrases that whisk you away to magical kingdoms of the mind. The computer becomes a tool of reaching that conveys you where it will. You go along eagerly, breathlessly, awaiting what comes next.

Such are the worlds created by Adams, Hassett, Li, and all the Adventure writers who have not yet been published. What they have in store for us next is anyone's guess. But I bet it's well worth waiting for. ■

Scott Adams Adventures are available on cassette tape for the 24 K-byte Apple II or Apple II Plus, the 48 K-byte Apple II with disk, the 16 K-byte Radio Shack TRS-80, and the 16 K-byte Exidy Sorcerer. Write:

Adventure International
POB 3435
Longwood FL 32750
(305) 862-6917

The Programmer's Guild Adventures are available on cassette tape or floppy disk for the 16 K-byte TRS-80. For information, write:

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The Greg Hassett Adventures are available on cassette tape for the 16 K-byte TRS-80 from:

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Zork and the Future of Computerized Fantasy Simulations

P David Lebling
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CFS (computerized fantasy simulation) games are a new art form: the computerized storybook. Instead of reading the story, you play it. The author presents the story, but only as you squeeze it out of him by wit and brute force. It's up to you to figure out what's going on, and the satisfaction of doing so depends on how well thought out the story is. To be fun to play, the story must be more or less consistent and complete. To a large extent, this means that the program that embodies the story must simulate the universe well.

I have been involved for several years with *Zork*, one of the larger and (I would like to think) better worked out CFS games. The authors (Marc Blank, Tim Anderson, Bruce Daniels, and I) have spent a lot of time trying to make the universe of *Zork* as consistent and complete as possible within the bounds of the space available. The first version of *Zork* was written for the Digital Equipment Corporation PDP-10; it eventually grew to strain even the megabyte address space of that machine. The game was completely rewritten for microcomputers and is now limited primarily by the size of a 5-inch floppy disk. *Zork* games swap data (programs and text) into memory from the disk as needed and therefore aren't limited by the size of the system's user memory.

Standard 5-inch floppy disks store about 100 K bytes (some store more, some less). This works out to about 10,000 words of English prose and a similar amount (about 40 K bytes) of code. This is large for a microcomputer-based program, but as literature it's still only at the short story length.

Zork is shrunk to fit into the micro-world by running on a *Zork-language virtual machine*. This means that the code that is running while you are playing *Zork* is much more compact than the same program would be if written in machine language (on a Radio Shack TRS-80, for example). This is because the instruction set of the virtual machine is tailored to CFS games. For example, the *Zork*-language instruction to move an object from one room to another takes just 3 bytes of storage. The other advantage is that the *Zork* code is machine independent; all it takes to move *Zork* to another machine is to write the *Zork*-language interpreter for that machine. Such interpreters currently exist for the Apple II, PDP-11, PDP-10 and the TRS-80. For more details about the *Zork*-language see "How to Fit a Large Program into a Small Machine," by Marc S Blank and S W Galley, July 1980, *Creative Computing*.

Even using a disk to store parts of the game, the PDP-10 *Zork* was still too large for the micro-world. As a result, we split it into two smaller, independent games: *The Great Underground Empire, Part I,* and *The Great Underground Empire, Part II,* each of which is a self-contained program. There was room left over, so we added some new problems to round things out.

Still, a lot of universe can fit into a microcomputer and disk. *Zork* "understands" a useful subset of English (mostly imperative sentences), including sentences as complex as "Put all of the books but the green one under the rug." The *Zork* vocabulary is over 600 words and includes 100 verbs. A parser this powerful is a good-news/bad-news proposition. On the one hand, such a parser makes possible the implementation of subtle and realistic problems. When the most complicated sentence you can understand is "Drop uranium," you are limited to producing certain types of situations. If you can say "Tell the Robot 'Put the uranium in the lead box'," then the game can become more interesting.

Zork has a fairly complicated parser for imperative sentences. It endeavors to reduce its input to a construction of:

<verb> <direct object> <indirect object>

where the objects are optional. Prepositions are folded in-

If you are interested in playing Zork: The Great Underground Empire, Part I, *the game is distributed by Personal Software, 1330 Bordeaux Dr, Sunnyvale CA 94086 on foppy disk for Apple II and TRS-80 computers.* Zork *games are produced by Infocom Inc, POB 120, Kendall Sta, Cambridge MA 02142.* Zork *is a trademark of Infocom Inc.*

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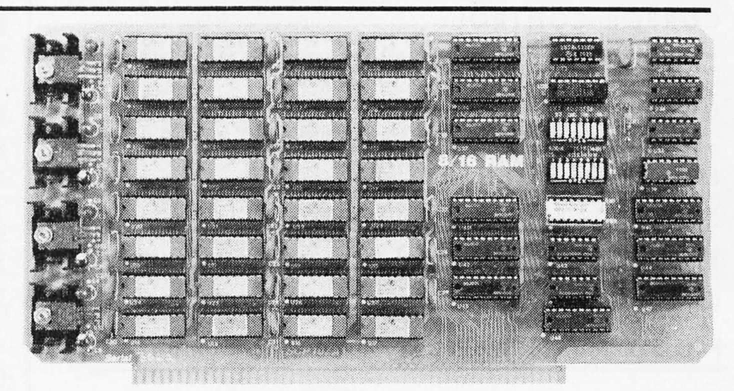
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One method of dealing with players who are "killed" in *Zork* is to resurrect them in a forest.

to the verb, which allows *Zork* to differentiate

>PUT BOMB UNDER TROPHY CASE

from

>PUT BOMB IN TROPHY CASE

(Lines beginning with > are the player's input.)

Similarly, adjectives are used to distinguish among several books, doors, or any collection of like objects. In conjunction with *all* and *but*, adjectives provide powerful constructs:

>TAKE ALL THE TREASURES
>BURN ALL THE BOOKS BUT THE BLACK ONE

The parser also allows the player to be laconic, if he so desires. If only one object in the vicinity fits the verb he uses, it will be selected and the player will be informed:

A menacing troll brandishing a bloody axe blocks all passages out of the room.
>KILL TROLL
(with sword)

If the meaning is not obvious, the player is asked to clarify, and the new input is added to the old to produce a complete sentence. This can go on indefinitely:

>OPEN
Open what?
>DOOR
Which door do you mean?
>THE TRAP DOOR

For more details on the *Zork* parser and internal structure, see "Zork: A Computerized Fantasy Simulation Game," by P David Lebling, Marc S Blank, and Timothy A Anderson, in *IEEE Computer*, April, 1979.

On the negative side, having a clever parser means that the player may expect almost any concept to be understood. Unfortunately, only a small number of concepts can be implemented given the available space.

Some concepts that *Zork* does implement are:

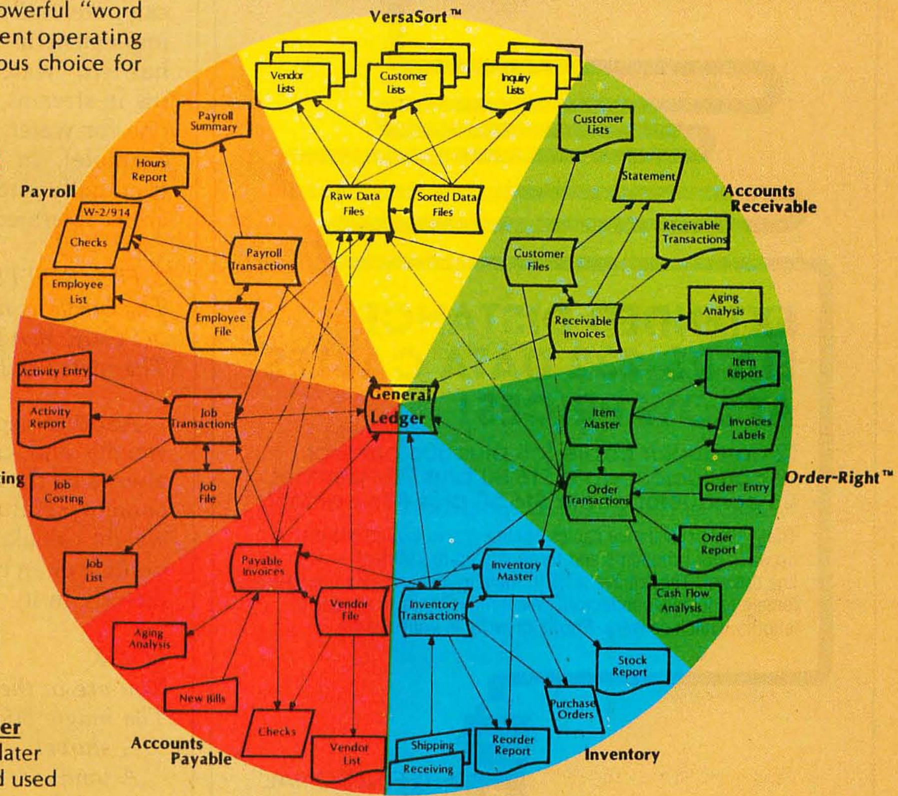
- **Properties:** Objects can have properties or attributes, some of them changeable. Lamps can be on or off, treasures valuable or worthless, villains fighting-mad or peaceful. Some of these properties never change; a container is always a container, for example. But other properties can change; for example, some containers may be opened and closed at will.
- **Containment:** Objects may have contents. Bottles can contain water and be open or closed. Some objects are transparent. Some objects must be unlocked before they can be opened. The capacity of an object is limited. (For example, a paper bag won't hold as much as a bucket.)
- **Weight:** Objects have weight. A solid gold coffin weighs a lot more than a newspaper. The amount a player can carry depends on the total number of objects carried and on the total weight of the objects and their contents.
- **Position:** An object may be in, on, or under another object.
- **Vehicles:** The player may be in a vehicle which is traveling through the locations in the game. In addition to the player, the vehicle may have other contents distinct from the player's belongings and the "contents" of the location.
- **Time:** Game events may be scheduled to happen at arbitrary future times. Time-bombs may go off, matches burn out, lanterns grow dimmer, and so on.
- **Actors:** Actors are other characters who have roles in the game. They may fight or choose not to. They may speak to the player or be spoken to. They may move around or stay in a particular place.
- **Fighting:** The player may engage in combat with other inhabitants of the game. He may be wounded (affecting his ability to carry heavy loads), or he may kill his opponent and retrieve the opponent's weapon.

Every object in *Zork* has a pointer to its location (which may be "nowhere"), which is its *parent;* a pointer to the next object in the same location, which is its *sibling;* and a pointer to its first contents, which is its first *child.* Thus, a container points to its contents, and the contents point back to it.

One result of this implementation is that an object can

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be in only one place at one time. Things like water, which can potentially be infinitely finely divided, are difficult to implement in *Zork* for this reason. Consequently *Zork* has two "water" objects; one for water in general (flowing in streams, filling reservoirs, leaking from pipes) and one for water in the player's possession (in a bottle, for example). In handling water, the general sort always eventually ends up as the specific sort, and exceptions aren't tolerated:

>FILL BOTTLE WITH WATER
The bottle is now full of water.
>POUR WATER
The water spills to the ground and evaporates.

Another aspect of containment involves problems of weight and capacity. The weight of an object must always be the sum of its own weight and the weight of its contents. Naturally, each of the contained objects has its weight calculated the same way. On the other hand, the volume of an object is filled only by the size of the objects directly in it.

LOOK
You are in the magic boat.
The magic boat contains:
  A shovel.
  A lamp.
  A solid-gold coffin.
  The solid-gold coffin contains:
    A brown sack.
    The brown sack contains:
      A lunch.
      A clove of garlic.

Of course, containers have other properties. They can be open or closed, opaque or transparent, locked or unlocked.

>INVENTORY
You are carrying:
A glass bottle.
The glass bottle contains:
  A quantity of water.
>DRINK WATER
I can't reach the quantity of water.
>OPEN BOTTLE
Opened.
>DRINK WATER
Thank you very much. I was rather thirsty.

The concept of a *surface* is implemented as a special kind of containment. Objects which have surfaces on which other objects may sit are actually containers with an additional property of "surfaceness."

Vehicles are an even more specialized case of containers. A vehicle has a property called the *action property* that is allowed a chance to give special handling to any input of the player. For example, a spaceship vehicle might want to restrict the player's movement during the acceleration phase of a flight or prevent him from taking objects that are outside the ship.

Possibly the most useful concept in *Zork* is that of *time*. An arbitrary event may be scheduled to occur at an



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arbitrary time in the future: for example, the discharging of the batteries in a lantern is controlled in this way.

Introducing time also introduces some problems. If an event is scheduled, the circumstances under which it is valid must be coded into it. Otherwise, the behavior of the game can appear nonsensical. Suppose the player lights the fuse on some dynamite. If he sticks around, he will be blown to smithereens. He runs away, only to find that the dynamite has apparently followed him. He still gets blown up because, when the explosion happens, the program doesn't check to see if he is still there.

One method of dealing with players who are "killed" in *Zork* is to resurrect them in a forest. In an early version of *Zork*, it was possible to be killed by the collapse of an unstable room. Due to carelessness with scheduling such a collapse, 50,000 pounds of rock might fall on your head during a stroll down a forest path. Meteors, no doubt.

In an effort to introduce a little more randomness into what was at one time a deterministic game, we added fighting. The player was allowed to attack any of the monsters or other characters he encountered during his travels. The scheme we implemented is conceptually simple. There is a range of possible outcomes for any attack, either by the player on a villain or vice versa. You can be killed outright, knocked unconscious, wounded, wounded seriously, staggered, or you can have your weapon knocked from your hand.

The villain, each time it is his turn to riposte, has the option of parrying or turning and running (if he is not limited to one room, as the troll is). Some weapons are better against certain opponents than others. The relative strengths of player and opponent figure into the outcome as well (the player's strength is a function of health and progress in the game). The results are a selection of appropriate messages describing the fight as it progresses.

>KILL THIEF WITH SWORD
Clang! Crash! The thief parries.
>AGAIN
The thief receives a deep gash on his side.
>KILL
The thief slowly approaches, strikes like a snake, and leaves you wounded.
>ATTACK
The thief is disarmed by a subtle feint past his guard. The robber, somewhat surprised at this turn of events, nimbly retrieves his stiletto.
>KILL THIEF
A good stroke! Blood wells down the thief's leg. You evidently frightened the robber. He flees, but the contents of his bag fall to the floor.

Well, he may live to fight another day, but you recovered some of his booty. Fighting in *Zork* is pretty primitive when compared to real life or even to a "melee" in the popular game *Dungeons and Dragons*. You could make combat more elaborate, and in fact there are CFS games that have gone in that direction, producing quite realistic "hack and slash" games.

Possibly, the most enjoyable aspect of writing *Zork* was designing the other characters the player may encounter. *Zork* contains various other *actors*, including a troll, a thief, a wizard, various monsters and friendly gnomes, and a beautiful princess. Some of these are pretty simple. The troll is basically an obstacle. He doesn't move but merely bars the way and must be defeated by force of arms.

The thief, on the other hand, is embodied by a complex program. After a while, he begins to take on a personality of his own: the slightly down-at-the-heels younger son of a noble family, perhaps. He is cultivated but has a rather nasty sense of humor. For example, his idea of fun is to foul up the standard Adventure maze-mapping technique of identifying rooms by dropping objects in them. When he finds a player doing that, he will wander around switching objects, no doubt chuckling all the while:

You are in a maze of twisty little passages, all alike.
>DROP KNIFE
Dropped.
In the distance, you hear a voice saying, "My, I wonder what this fine rope is doing here?"

Some actions of the thief are motivated by the characterization; he is unlikely to kill you during a fight if he knocks your weapon out of your hand—too well bred. On the other hand, maybe his thiefly reflexes will get the better of him . . . . Many of the thief's actions are motivated by simple probability. There is a certain chance he will stop in any room while roaming around, a certain probability that he will steal any particular object (high for treasures, of course), and a probability that he will decide to attack the player. His behavior, nonetheless, can seem very realistic: Sometimes he seems to dog

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the player, who no sooner finds a treasure than the thief filches it.

There is a rich range of possibilities in producing games in which characters in the story (other than the player) act more like real people and less like monsters or one-dimensional villains. But the simulation of human behavior is still an unsolved problem in the field of artificial intelligence. The best approximations to date have been the classic simulations of a nondirective psychotherapist (Weizenbaum's Eliza) and of a psychotic paranoid (Colby's Parry). But even they would not make very interesting characters in a story. (These two curious beings actually met once, as recorded in "Parry Encounters the Doctor" by Vinton Cerf, in *Datamation*, July 1973.)

There are other, more mundane areas in which *Zork* could be extended. For example, take a simple concept like clothing. If the player can reference his *clothing* (or even a magic ring he might be wearing) some interesting questions arise. Is there a distinction between wearing something and carrying something? Probably, because when the player says "drop all," he probably doesn't mean to include his clothes. Also, the existence of clothes probably means the definition of many parts of the body. You could take this to extremes:

>INVENTORY
You are empty-handed.
You are wearing a diamond ring on your right index finger.
You are wearing bells on your toes.
You are wearing a coonskin cap on your head.

Of course, if you implement clothes, there might as well be pockets, and backpacks, and other "different" sorts of containers. It would have to be defined whether the player can reference things inside them (what if the flap of the backpack is closed, for example?). What happens if he falls into a lake? Do the clothes drag him down? What about wearing a suit of armor? Clothes probably need a weight or need to produce a fatigue effect on the player.

The mention of falling into a lake brings up another possible extension to *Zork*. Currently players aren't allowed to swim. One reason was to avoid the problems associated with the player's belongings dragging him under. Another is the question of what happens to his belongings. Do they get wet? If so, do they ever dry out again? What about wet matches (to give one example)? Is wet paper still burnable? How long can the player swim? Can he hold his breath and swim underwater? There are any number of questions that have to be considered if such a feature is to be implemented.

Even the addition of a run-of-the-mill object can produce complications. In early versions of *Zork*, the troll's axe disappeared when he was killed. We finally decided to let the player recover it, as advances in *Zork* weapons technology removed the reason for destroying it. Unfortunately, we didn't think it through. One of our best play testers, on hearing that "you can finally get the axe," immediately said, "Great, I'm going to go up to the forest and chop down some trees." Oops. We never thought of that, not to mention using the axe to chop through doors, split timbers, and any number of other commonplace uses for something we were thinking of strictly as a weapon.

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The authors of *Zork* have thought about several possible extensions to the *Zork* parser. One that has come up many times is to add adverbs. A player should be able to do the following:

>GO NORTH QUIETLY
You sneak past a sleeping lion who sniffs but doesn't wake up.

The problem is to think of reasons why you would not do everything "quietly," "carefully," or whatever. Perhaps there should be time and fatigue penalties for doing things in a nonstandard way:

>SEARCH WALL CAREFULLY

This would take a long time (and all the while the lamp is burning down), possibly tiring the player out. To be fair to the player, he should not need to search every wall carefully, or walk quietly everywhere. There should be reasonable clues or hints as to why and where he should do such things.

This long discussion of the problems of extending *Zork* is not intended to scare anyone (including the authors of the game). The idea is to show that apparently simple extensions to the game have their nonobvious ramifications. Of course, it would be simple to ignore them, but we think that the authors of a game should play fair with the players. Just as it's disappointing to see the wires holding up Flash Gordon's spaceship, it's disappointing to see:

>PUT RING ON FINGER
I don't know the word 'finger'.

We authors would hardly claim that *Zork* is perfect in this respect, but we have made an effort in that direction. When we add something new, we try to think of how the player might try to use it and what verbs he might try to apply to it. Within the space available, we've tried to put most of those things in.

All the CFS games that I have encountered are similar in one major respect: they are about problem solving and the acquisition of treasure. This is probably because a structure containing problems and rewards is obvious and easy to implement.

It is possible to imagine games in which the goals are different. Some programmers in southern California have designed a game in which the moral choices the player makes have a significant impact on the game. For example, does the player give an old man some water? Similarly, the problem-solving idea could be shifted into something closer to scientific research. The player could be introduced into an environment where he performs experiments, ponders the results, and ultimately gains understanding and control of that environment.

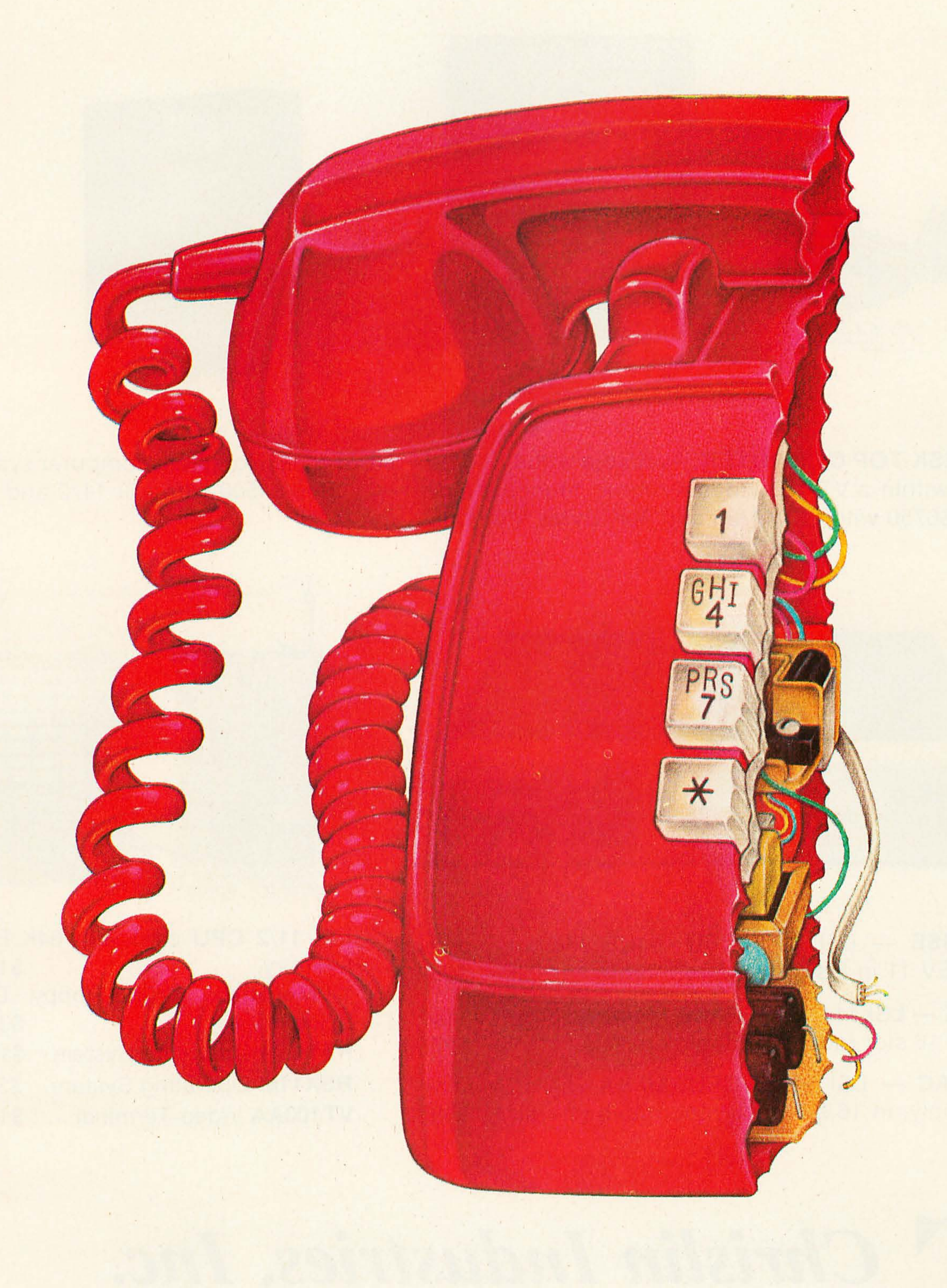
Innovations in form as well as content are possible. There are already CFS games that try to give the player a graphic view of his surroundings. As microcomputer technology advances, this will become more common, and the renditions will achieve higher quality: it will be technically feasible to have a CFS game "illustrated" by Frank Frazetta or Jeff Jones. On the other hand, the player's imagination probably has a more detailed picture of the Great Underground Empire than could ever be drawn. I can even recall discussions among the game's implementors over who should play the thief in the movie version.

Another area where experimentation is going on is that of multiplayer CFS games. Each player (possibly not even aware how many others are playing) would see only his own view of the territory. He would be notified when other players enter or leave the room, and could talk to them. There was briefly a multiplayer version of the PDP-10 *Zork* several years ago, and today there is a "Multiple User Dungeon" at Essex University in England.

There are major problems, however. One is producing problems that are compatible with different numbers of players (from one to, say, a dozen). If it takes five players to solve a problem (one to hold the light bulb and four to turn the ladder?), what happens if only two people are playing? The other problem, as far as the microcomputer owner is concerned, is that few can afford an unlimited number of machines or even video monitors to accommodate so many players.

CFS games as an art form can continue to grow as long as their medium continues to grow. *Zork* is already constricted by the size of today's microprocessors (it was large even on the PDP-10), but the new generations of 16- and 32-bit machines offer the opportunity of enormous further growth. The possibilities of new concepts, new milieux, and new purposes are enormous. We would like to think that it will not be long before authors view such scenarios as just another medium of expression. I find the prospect exciting because I enjoy playing CFS games as much as writing them.■

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Character Variation in Role-Playing Games

Jon Freeman
Automated Simulations Inc
1988 Leghorn St
Mountain View CA 94043

Editor's Note: *This issue is concerned with Adventure and its variants. Some Adventure enthusiasts will claim that games like Automated Simulations'* Morloc's Tower *(see a review of this game on page 84) are not* really *Adventures. To see that this is rightly so, contrast this article by Jon Freeman, creative director for Automated Simulations, with the Adventure article, "On the Road to Adventure," by Bob Liddil (page 158).*

But this is not to say that the Dunjonquest games and an increasing number like them are not "as good as" the more conventional command-and-answer Adventure games. Rather, they emphasize a different set of values that capture the player's imagination in another, equally engaging way. Players of Dungeons and Dragons *and other role-playing games will find a lot of the* Dungeons and Dragons *philosophy used in Automated Simulations' Dunjonquest games. Unlike* Dungeons and Dragons, *however, computer-aided games of this sort have the advantage of running in real time. A fight that could take 15 minutes to resolve in* Dungeons and Dragons *will only take 10 seconds to resolve with these games, so you'd better be fast on your keyboard! . . .*GW

The peculiar attraction of *Dungeons and Dragons, Tunnels and Trolls, Traveller,* and other similar games stems, I believe, from two things: open-endedness and role-playing. Anything can happen: as a player in such a game, you may be attacked by 1,000 goblins or a jealous lover, contract a disease, acquire a new suit of armor, or inherit one hundred dollars—er, gold pieces. Anything can be done, from fighting a dragon to begging a wizard's forgiveness, from besieging a castle to kissing a frog. And it never stops, except temporarily: there is no final victory, no point to playing except playing, and no ultimate aim except the continuing development of your "character"—the alter ego who stalks the imagined landscape in your stead.

> There is no role-playing in games of the Adventure/*Zork* family.

Even microcomputers in a fraction of a second can make complicated calculations that would take a *Dungeons and Dragons* referee minutes of page-turning and piles of charts. However, no computer games can handle all the aspects alluded to above as well as the best-run noncomputer games. Computer-based games can therefore be grouped according to which aspects they emphasize and which they ignore.

There is no real role-playing, for instance, in the Adventure/*Zork* family: the protagonist is just you in a strange setting. Games of that sort concentrate on the perceived open-endedness of action: not only is there a multitude of command options available (typically far more than Dunjonquest's eighteen or so), but also they are not made known to you except by trial and error. It can be quite challenging to find the right key, the right moment, and the right command necessary to insert it in the right lock; but once you do, the door will open—always. Thus, a game like Adventure is really a puzzle that, once solved, is without further interest.

Character Variation in Dunjonquest

The Dunjonquest series employs a different approach. For one thing, situations are primarily defined graphically, not textually: you see the situation rather than just being told about it. More to our present purpose, while some Dunjonquest games, like *Morloc's Tower,* have a specific object (finding and slaying the mad and elusive wizard Morloc), there is an open-endedness of result in all of them on the micro level (if you'll excuse a small pun). Generally speaking, there are no "right" answers; the outcome of events is probabilistic, not predetermined.

Brian Hammerhand, the assigned alter ego/protagonist of *Morloc's Tower* and *The Datestones of Ryn,* can, for example, slay a dire wolf nine times out of ten, but on any particular occasion he may survive the encounter unscratched, or limp away badly mauled and out of breath—and there is also that tenth time. Moreover, the exact outcome of any encounter depends both on the tactics you choose and on the specific traits of your surrogate character. The experience is different every time you play and quite different with each new character you take on your adventure. You are role-playing: getting outside youself and into the skin of another (albeit imaginary) being.

In *The Temple of Apshai, Hellfire Warrior, The Cliffs of Tyyr,* and others in the Dunjonquest series, six traits or attributes are used to distinguish Samson the Strong from Cugel the Clever, and Dorgon the



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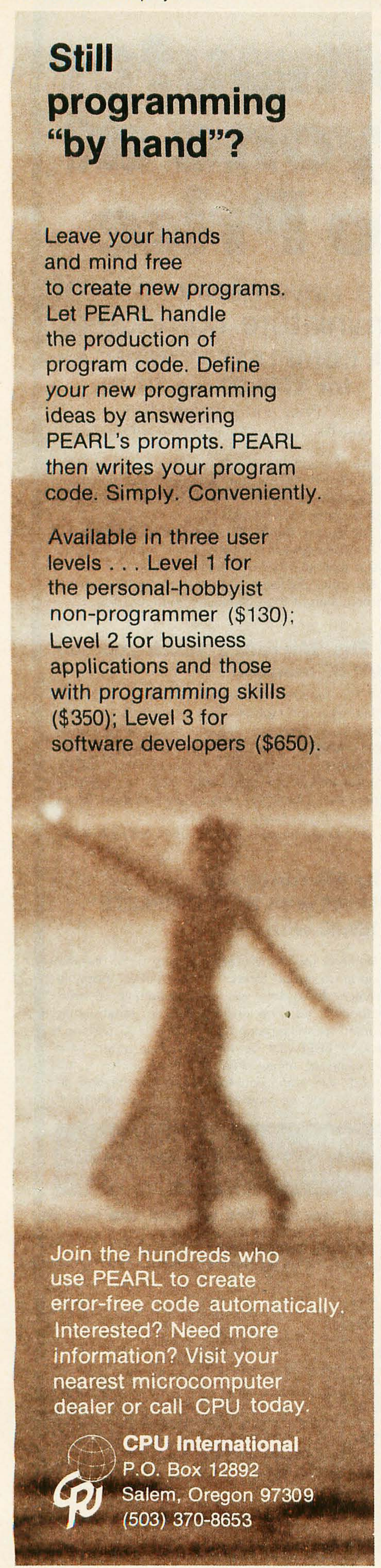
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Dolt from either. Three traits (ego, intelligence, and intuition) cover the mental aspects of a character, and three traits (dexterity, strength, and constitution) cover the physical attributes. Each of these is assigned a number (randomly, if the program is creating the character) from a low of 3 to a high of 18—the equivalent of rolling three six-sided dice, which is how such characters are normally created in games like *Dungeons and Dragons*. (This commonality allows you to bring characters from "outside" into the Dunjonquest world.)

The numerical valuation permits the use of charts and tables, or computer calculations, to affect or resolve outcomes during the course of the adventure. It also permits 16^6 = 16,777,216 different characters, which is enough to allow all the variation you could ask for *if* the system is set up to handle it.

Dexterity and Constitution

In the Dunjonquest systems, character variation affects the game in many ways. For instance, in any round of combat between an adventurer (you and your character) and a monster (dragon, troll, goblin, common thug, etc), there is a chance the character will strike the monster with his sword, and a separate chance that the monster will strike the adventurer with his teeth/claws/club/bad breath. *Dexterity*, representing a combination of reflexes, coordination, speed, etc, interacts with the adventurer's choice of weapons in a complex way to modify those combat probabilities.

Simply put, with a dexterity of 4, Cleavon the Clumsy has trouble keeping his shield out of his own way; he spends much of his time futilely slicing the air and is an easy target for attacking monsters. In contrast, Flash Farrad (dexterity 17) will hit his opponent far more often and will block more blows with his shield. Reasonably enough, since Farrad is better at hitting where he aims, his advantage over Cleavon extends to the amount of damage he is likely to do (but other factors — size of the weapon and strength of the sword arm — enter in; see the following).

Constitution, a measure of health and endurance, is perhaps the single most important trait, since it represents specifically the number of points of damage a character can sustain before dying. A monster must do exactly three times as much damage to Steel Strongheart (constitution 18) to kill him as it would take to do in poor Ferdinand the Frail (constitution 6). (In fact, Ferdinand is too sickly to pass muster in the Dunjonquest **character-generation** sequence, which rejects hopelessly inferior characters.) Furthermore, Ferdinand will tire (from moving or fighting) three times as fast as Steel. Since fatigued characters must rest or risk falling easy prey to monsters through sheer exhaustion, even running away can be hazardous to unhealthy adventurers.

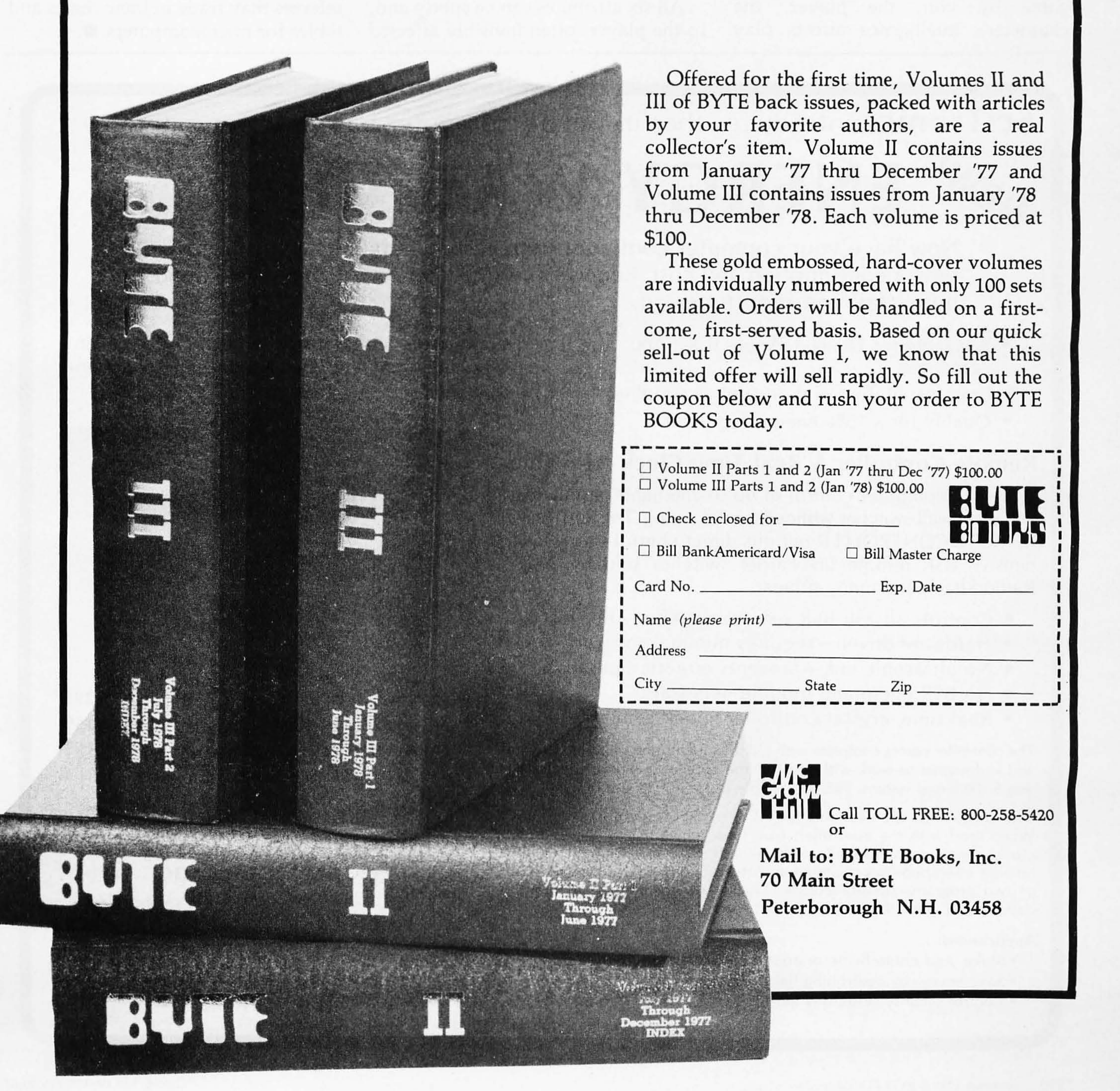
Strength and Ego

Strength measures how strong the character is and affects damage done in combat both directly and indirectly. Heavier weapons do potentially more damage, but not all characters can wield even a broadsword, and only the strongest can manage a hand-and-a-half sword one-handed. More directly, the nominal damage (obtained by a random "die roll" itself affected by dexterity and other factors) done by the adventurer to the monster he is fighting is multiplied by one-tenth the strength value to determine the gross damage done. On a "roll" that yields a nominal damage of five points, Nerdley the Not-so-Strong (strength 8) actually does only 5 x .8 = 4 points of damage, while Manfred the Mighty (strength 16) would receive 5 x 1.6 = 8 points of damage out of the same swing of a sword. Strength is also part of the complex algorithm used to calculate fatigue, which is, in part, related to the ratio between the amount of weight an adventurer is carrying at any moment and the square of his strength. Stronger characters can manage heavier armor and more treasures without strain.

Ego is a measure of mental toughness and willpower. In part, it expresses the differing reactions of people to stress: in a bad situation, Casper Milquetoast (ego 3) gives up, while Darvon the Determined (ego 16) redoubles his efforts. This translates into an increase (for Darvon) or decrease (for Casper) in the probability that either will strike the monster he is fighting; the value of the increase/decrease is dependent on the extent of their injuries.

In Dunjonquest games in which the

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protagonist is a magician, ego affects the power of a spell much the same way strength modifies a physical attack. In all games, ego is added to intelligence to determine the success of a character's attempt to parley with a monster. Finally, it interacts with intelligence in a more complex way to affect a character's ability to bargain in the Inn, Apothecary, and Magic Shoppe.

Intelligence and Intuition

Intelligence in Dunjonquest is limited to the "left-brain" powers of logical reasoning and verbal expression. Since it most closely represents that quality brought to bear on the game by you, the player, the character's intelligence affects play less than any other attribute. It helps or harms the ordinary adventurer chiefly in his negotiations with monsters or the Innkeeper and company, and it controls the complexity of spells used.

The final attribute, *intuition,* is the complement of intelligence: it covers real and imagined "right-brain" functions like spacial perception, ESP, and luck. The probability of finding secret doors, traps, and monsters lurking in the next room is directly dependent on the attribute of intuition. Poul the Perceptive (intuition 15) finds secret doors with ease; Igor the Insensitive (intuition 5) finds traps only by falling into them.

All six attributes can be subtly and, to the player, often invisibly affected by potions and magical devices, enhanced by experience, or decreased by "undead" monsters like spectres, shades, and such. In fact, by means of the subtle but significant effects of incremental alterations in each attribute, the speed and power of a computer allow for more meaningful variation in *[and more objective evaluation of . . . . GW]* individual characters than would any noncomputer role-playing game yet published. Since monsters are even more complicated and individualized than adventurers, the variety of possible events and outcomes is truly mind-boggling. Once the hard-core fantasy enthusiasts realize this, even the referees may trade in their charts and tables for microcomputers. ■

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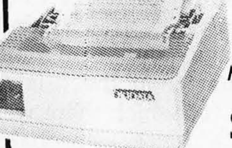


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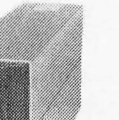
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Pirate's Adventure

Scott Adams
Adventure International
POB 3435
Longwood FL 32750

A Short History

Time flies. The copyright date on my game, *Pirate's Adventure*, reads 1978. It seems like yesterday, but it has been two and a half years since I started on my Adventures . . .

At the time I was working as a systems programmer for Stromberg Carlson when I was first introduced to the classic *Adventure* game written by Crowther and Woods to run on a DEC (Digital Equipment Corporation) PDP-10. After playing for only a few minutes I was hooked. It took almost ten days of early-morning and late-evening sessions before I achieved the coveted score of 350 and the title of Grand Master. I had done it—I was a *bona fide* adventurer! Yet it seemed unfair that such a fascinating game was restricted to such an expensive machine.

Back then, I had just gotten my Radio Shack TRS-80 Level II computer, and (having recently finished my backgammon program) I was looking for another good game to write. The concept of character strings intrigued me, and I wanted a game that used them. (Up to that point, I had programmed primarily in FORTRAN and assembly language, neither of which can handle strings easily.)

Adventure seemed to fit my needs exactly. But I didn't want to copy someone else's program, and I was afraid I wouldn't get much of an Adventure in a 16 K-byte BASIC computer—especially when the FORTRAN version I played took about 300 K bytes!

I mentioned the idea of getting some sort of Adventure into my small machine to friends; fortunately, I was not daunted by their laughter. After all, I could remember when it was supposedly impossible to get a BASIC interpreter to run on an 8080 microprocessor!

Interpreter? Did I say *interpreter?* Suddenly the idea fell into place! I had written many compilers and operating systems. Why not write an Adventure interpreter? This would allow me to write many Adventures and would also provide the compression I needed to fit them into a small machine. (Inside, I'm really a frustrated science-fiction writer; I have over 3000 science-fiction books in my collection but have never tried to write one myself.)

It seemed unfair that such a fascinating game was restricted to such an expensive machine.

So, weeks later, my initial scribblings had evolved into a working interpreter with a skeleton Adventure to play on it. It took some six months of play-testing before my first Adventure, *Adventureland*, was finally released through The Software Exchange of Milford, New Hampshire, and Creative Computing Software. Thus the Scott Adams Adventure Series was born.

And, at that same moment, it almost died. For six months I had been so engrossed in programming Adventure that my wife Alexis (who at the time was pregnant with Maegen, our daughter) started hiding my floppy disks around the house to get my attention. Once she hid them in the oven—boy, did she get some attention that time! I then decided that one Adventure was enough.

Some time after that, Alexis unexpectedly announced that she wanted to write an Adventure, and it was this effort that led to the Scott Adams Adventure given in *listings 1 and 2*, *Pirate's Adventure*. With her basic ideas, we created an Adventure that was different from any that had ever been written before. Instead of simply searching for treasures in this Adventure, you now had an added ingredient—a "mission." (In this case, you had to figure out how to build a pirate's ship!) This set the stage for many of my later mission-oriented Adventures that replace a cumulative score with a do-or-die situation. These include my *Mission Impossible, The Count, Voodoo Castle,* and *Mystery Fun House* Adventures.

All my current Adventures, for the Apple II, the Radio Shack TRS-80, and the Exidy Sorcerer, are written in machine language and run much faster and cleaner than the original BASIC versions (of which there were only two and a half). I probably would never have written these programs in machine language if it had not been for the gentle nudges I received from a friend I've never met but greatly respect, Lance Micklus.

Program Notes

Pirate's Adventure was first sold commercially to run in Level II BASIC on a 16 K-byte TRS-80. Both the Adventure-interpreter program (in BASIC) and a data file created by the Adventure-editor program were on the cassette tape. After you loaded the interpreter program, you used it to read the data file, an operation that took 20 minutes but allowed me to compress a lot of Adventure into very little memory space.

In planning this article, I had to devise a means of creating the tape data file without using the Adventure editor. The BASIC program in listing 1 provides the means. This program, which runs on a TRS-80 with 16 K

Text continued on page 212
See pages 194 thru 210 for listings

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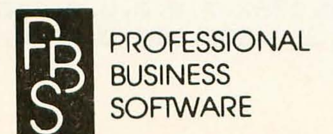
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Listing 1: *Data-tape generation program for Scott Adams'* Pirate's Adventure, *written for the Radio Shack TRS-80 Model I running Level II BASIC.*

```
6010 '     **** BE SURE AND USE A C-60 TAPE FOR YOUR DATA TAPE!!!!
6020 ' ADVENTURE DATA TAPE BUILDER. BUILDER/BAS
6030 ' VERSION 1.3 (C) SCOTT ADAMS '80.
6040 ' ADVENTURE INTERNATIONAL BOX 3435 LONGWOOD FL 32750
6050 ' PHONE (305)-862-6917
6060 ' BUILDS DATA TAPE FOR ORIGINAL BASIC VERSION OF PIRATE'S ADVENTURE
6070 'PLEASE NOTE ON LINES THAT SUDDENLY GO TO THE
NEXT LINE LIKE
THIS USE (DOWN ARROW) KEY WHICH IS RIGHT ABOVE
THE LEFT HAND SHIFT KEY ON YOUR TRS-80!
6080 DATA 60, 151, 59, 33, 5, 1, 2, 3, 200, 71, 1,80,422,342,420,340,0,16559,885
0,80,462,482,460,0,0,15712,1705,100,521,552,540,229,220,203,8700,3,483,0,0,0,0,1
5712,0,100,284,0,0,0,0,8550,0,100,28,663,403,40,0,8700,0,100,48,20,660,740,220
6090 DATA9055,10902,100,28,20,0,0,0,3810,0,100,8,700,720,0,0,10868,0,100,48,40,6
40,400,300,9055,8305,25,664,0,0,0,0,4263,0,40,104,886,0,0,0,4411,0,80,242,502,82
0,80,240,9321,10109,100,8,140,80,500,0,10262,8850,35,421,846,420,200,0,5162,0
6100 DATA100,129,120,0,0,0,6508,0,50,242,982,820,440,240,9321,8850,35,483,69,0,0
,0,15705,0,10,483,249,0,0,0,15706,0,50,484,1073,1086,0,0,17661,9150,50,204,1086,
0,0,0,16711,0,10,209,1040,1060,300,1100,10872,10050,10,208,1040,1060,89,0,10867
6110 DATA0,85,483,8,0,0,0,15719,10200,100,8,0,0,0,0,10200,0,100,104,0,0,0,0,8550
,0,80,462,282,280,1160,0,1422,0,158,82,60,0,0,0,8170,9600,4510,61,0,0,0,0,300,0,
163,22,100,0,0,0,8170,9600,8100,0,0,0,0,0,16200,0,4800,104,120,61,0,0,10507
6120 DATA8164,4800,107,100,61,89,0,10507,8164,4063,22,0,0,0,0,647,0,5570,161,203
,160,180,0,10870,1264,6170,181,180,160,0,0,8302,0,6300,104,0,0,0,0,900,0,1529,44
2,465,440,0,0,7800,0,1529,442,462,0,0,0,760,9150,183,322,180,0,0,0,8170,9600
6130 DATA1538,262,242,0,0,0,1800,0,1538,262,245,260,0,0,7800,0,5888,262,242,0,0,
0,1800,0,5888,262,245,0,0,0,1950,0,6188,262,245,541,260,560,2155,7950,5888,261,0
,0,0,0,2400,0,4088,561,0,0,0,0,2400,0,4088,263,0,0,0,0,2713,0,4088,562,580,109
6140 DATA100,249,2303,8700,4088,249,562,108,900,240,6203,8700,4088,248,562,0,0,0
,6600,0,4068,103,69,0,0,0,646,0,4068,103,68,0,0,0,6600,0,5887,342,0,0,0,0,2550,0
,5887,362,0,0,0,0,2713,0,5887,382,0,0,0,0,2100,0,159,382,320,0,0,0,8170,9600
6150 DATA6187,342,362,0,0,0,2550,0,6187,345,362,541,360,380,8303,10050,3461,503,
0,0,0,0,172,0,3750,0,0,0,0,0,9900,0,1528,0,0,0,0,0,9900,0,4108,1143,1012,0,0,0,6
46,0,6450,0,0,0,0,0,2853,0,4510,66,0,0,0,0,2720,0,4950,0,0,0,0,0,9750,0,5114,0
6160 DATA0,0,0,0,10650,0,7092,592,0,0,0,0,2745,0,185,284,140,0,0,0,8156,10564,40
98,1054,0,0,0,0,647,17550,4098,1053,0,0,0,0,647,17400,4083,322,0,0,0,0,647,0,409
5,762,0,0,0,0,647,0,195,782,921,0,0,0,2727,0,195,762,261,0,0,0,2727,0,6900,0,0
6170 DATA0,0,0,9450,0,1526,602,0,0,0,0,2723,0,1541,621,602,640,520,600,7853,8250
,195,782,661,0,0,0,2727,0,7092,623,583,303,643,20,8700,0,7092,0,0,0,0,0,3750,0,2
00,722,220,0,0,0,10554,9600,195,762,61,0,0,0,2727,0,4050,0,0,0,0,0,10564,0,1526
6180 DATA523,520,0,0,0,7800,0,195,762,340,0,0,0,8126,8464,195,782,360,0,0,0,8157
,10564,7530,404,242,1053,89,0,17250,0,4800,0,0,0,0,0,450,0,5868,103,200,69,60,0,
4553,8700,5868,68,0,0,0,0,494,0,1546,146,0,0,0,0,4800,0,1546,802,141,140,840,0
6190 DATA8302,0,2746,841,840,140,0,0,8302,4950,3496,802,0,0,0,0,811,0,3496,841,8
40,140,0,0,811,8302,7366,822,820,240,400,0,5305,9300,5861,503,0,0,0,0,2100,0,841
1,501,500,140,0,0,5459,7833,192,742,400,0,0,0,8170,9600,201,404,88;420,240,242
6200 DATA8170,8071,201,404,89,120,0,0,8170,9600,7530,404,245,0,0,0,2737,0,7530,4
04,912,0,0,0,2738,0,7530,404,89,80,740,420,5908,9300,7530,404,88,80,740,120,5910
,9300,7671,0,0,0,0,0,6000,0,4553,903,0,0,0,0,6300,0,1350,0,0,0,0,0,6000,0,1510
6210 DATA62,60,0,0,0,7800,0,5860,63,0,0,0,0,18000,0,201,404,88,420,0,0,8170,9600
,186,284,360,0,0,0,8170,9600,1539,482,242,0,0,0,1800,0,1539,482,480,0,0,0,7904,1
6800,194,682,300,0,0,0,8170,9600,174,149,464,140,0,0,8751,0,174,160,0,0,0,0
6220 DATA8751,0,7800,444,940,921,952,0,10548,8014,7800,124,921,0,0,0,7350,0,7800
,424,992,980,921,0,10553,7264,8250,104,0,0,0,0,10505,9600,7800,464,148,1140,921,
1152,10553,7264,1541,643,640,0,0,0,7800,0,163,104,40,0,0,0,8170,9600,6300,44,0
6230 DATA0,0,0,15450,0,4534,583,0,0,0,0,4650,0,6187,702,541,0,0,0,2713,16050,588
7,702,0,0,0,0,2713,0,5887,0,722,0,0,0,2100,0,198,1022,480,0,0,0,8170,9600,157,2,
24,40,0,0,8170,9600,1510,44,60,40,80,85,7801,10800,1532,302,208,300,0,0,7800,0
6240 DATA1532,302,209,0,0,0,2813,0,1532,305,0,0,0,0,10518,7564,8411,841,840,140,
0,0,8922,0,165,1122,500,0,0,0,8170,9600,1392,0,0,0,0,0,6000,0,6300,284,0,0,0,0,1
6350,0,8582,0,0,0,0,0,17700,0,7800,921,209,302,200,0,8700,0,7950,0,0,0,0,0,2700
```

Listing 1 continued on page 198



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CORVUS CONSTELLATION	595
16K MEMORY UPGRADE KIT (TRS-80, APPLE II, SORCERER	60
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SMARTERM 80 COL	335
Mountain Computer	
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INTROL/X-10 controller card only	165
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SPACE INVADER (Disk.)	23
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FORTH II by PROGRAMMA SOFTWARE	45
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APPLESOFT UTILITY PROGRAMS BY HAYDEN	27
The CORRESPONDENT	35
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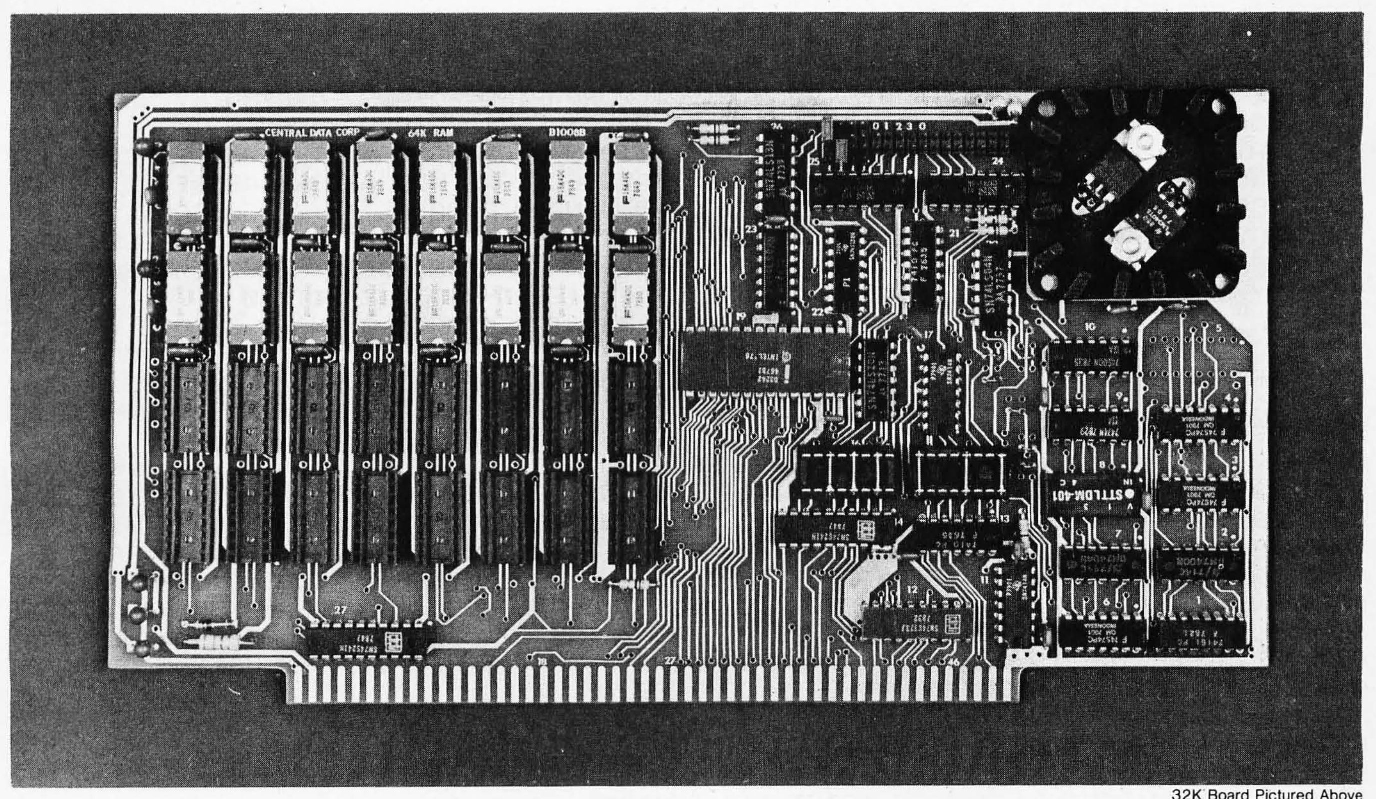
Circle 130 on inquiry card.

Circle 130 on inquiry card.

Listing 1 continued:

```
6250 DATA0,5908,621,1143,1000,0,0,4553,0,5266,0,0,0,0,0,1800,0,6300,224,0,0,0,0,
17517,17850,1200,0,0,0,0,0,17100,0,6300,124,0,0,0,0,16350,0,4350,208,1040,1060,0
,0,10919,0,6300,184,242,0,0,0,3600,0,7800,921,160,140,0,0,7410,9000,6300,0,0,0
6260 DATA0,0,450,0,AUT,ANY,GO,NORTH,*CLI,SOUTH,*WAL,EAST,*RUN,WEST,*ENT,UP,*PAC,
DOWN,*FOL,STA,SAY,PAS,SAI,HAL,GET,BOO,*TAK,BOT,*CAT,*RUM,*PIC,WIN,*REM,GAM,*WEA,
MON,*PUL,PIR,FLY,ARO,DRO,BAG,*REL,*DUF,*THR,TOR,*LEA,OFF,*GIV,MAT,DRI,YOH,*EAT
6270 DATA30,INV,LUM,SAI,RUG,LOO,KEY,*SHO,INV,WAI,DUB,REA,SAI,.,FIS,YOH,ANC,SCO,S
HA,SAV,PLA,KIL,CAV,*ATT,PAT,LIG,DOO,.,CHE,OPE,PAR,*SMA,HAM,UNL,NAI,HEL,BOA,AWA,*
SHI,*BUN,SHE,,CRA,QUI,WAT,BUI,*SAL,*MAK,LAG,WAK,*TID,SET,PIT,CAS,SHO,DIG,*BEA
6280 DATABUR,MAP,FIN,PAC,JUM,BON,EMP,HOL,WEI,SAN,,BOX,,SNE,0,0,0,0,0,0,,0,0,0,0,
0,0,APARTMENT IN LONDON,0,0,0,0,0,1,ALCOVE,0,0,4,2,0,0,SECRET PASSAGEWAY,0,0,0,3
,0,0,MUSTY ATTIC,0,0,0,0,0,0
6290 DATA*I'M OUTSIDE AN OPEN WINDOW ON A LEDGE ON THE SIDE OF A
VERY TALL BUILDING,0,0,8,0,0,0,SANDY BEACH ON A TROPICAL ISLE,0,12,13,14,0,11,MA
ZE OF CAVES,0,0,14,6,0,0,MEADOW,0,0,0,8,0,0,GRASS SHACK,10,24,10,10,0,0,*I'M IN
THE OCEAN,0,0
6300 DATA0,0,7,0,PIT,7,0,14,13,0,0,MAZE OF CAVES,7,14,12,19,0,0,MAZE OF CAVES,0,
0,0,8,0,0,*I'M AT THE FOOT OF A CAVE RIDDEN HILL.
A PATH LEADS TO THE TOP,17,0,0,0,0,0,TOOL SHED,0,0,17,0,0,0,LONG HALLWAY,0,0,0,1
6,0,0,LARGE CAVERN,0,0,0,0,0
6310 DATA14,*I'M ON TOP OF A HILL. BELOW IS PIRATES ISLAND. ACROSS THE SEA
OFF IN THE DISTANCE I SEE *TREASURE* ISLAND,0,14,14,13,0,0,MAZE OF CAVES,0,0,0,0
,0,0,*I'M ABOARD PIRATE SHIP ANCHORED OFF SHORE,0,22,0,0,0,0
6320 DATA*I'M ON THE BEACH AT TREASURE ISLAND,21,0,23,0,0,0,SPOOKY OLD GRAVEYARD
 FILLED WITH PILES
OF EMPTY AND BROKEN RUM BOTTLES,0,0,0,22,0,0,LARGE BARREN FIELD,10,6,6,6,0,0,SHA
LLOW LAGOON.
TO THE NORTH IS THE OCEAN,0,0,0,23,0,0
6330 DATASACKED AND DESERTED MONASTARY,0,0,0,0,0,0,,0,0,0,0,0,0,,0,0,0,0,0,0,,0,
0,0,0,0,0,,0,0,0,0,0,0,,0,0,0,0,0,0,,0,0,0,0,0,0,.,0,0,0,0,0,0,*WELCOME TO NEVER
 NEVER LAND,,THERE'S A STRANGE SOUND
6340 DATATHE NAME OF THE BOOK IS -TREASURE ISLAND-
THERE'S A WORD ENGRAVED IN THE FLYLEAF -YOHO-
AND A MESSAGE -LONG JOHN SILVER LEFT 2 TREASURES ON TREASURE
ISLAND!-,NOTHING HAPPENS,THERE'S SOMETHING THERE ALRIGHT. MAYBE I SHOULD
6350 DATATHAT'S NOT VERY SAFE,YOU MAY NEED MAGIC HERE,EVERYTHING SPINS AROUND AN
D SUDDENLY YOU ARE ELSEWHERE...,TORCH IS LIT,I WAS WRONG. I GUESS ITS NOT A MONG
OOSE CAUSE THE SNAKES BIT IT.,I'M SNAKE BIT
6360 DATAPARROT ATTACKS SNAKES AND DRIVES THEM OFF,PIRATE WON'T LET ME,ITS LOCKE
D,ITS OPEN,THERE ARE A SET OF PLANS IN IT,NOT WHILE I'M CARRYING IT,CROCS STOP M
E,SORRY I CAN'T,WRONG GAME YOU SILLY GOOSE!,I DON'T HAVE IT
6370 DATAPIRATE GRABS RUM AND SCUTTLES OFF CHORTLING,...I THINK ITS ME. HEE HEE.
,ITS NAILED TO THE FLOOR!,-MAGIC WORD- HO AND A ...      (WORK ON IT. YOU'LL GET
 IT),NO. SOMETHING IS MISSING!,IT WAS A TIGHT SQUEEZE!,SOMETHING WON'T FIT
6380 DATASINCE NOTHING IS HAPPENING,I SLIPPED AND FELL...,SOMETHING FALLS OUT,TH
EY'RE PLANS TO BUILD JOLLY ROGER (A PIRATE SHIP!)
YOU'LL NEED HAMMER NAILS LUMBER ANCHOR SAILS AND KEEL.,I'VE NO CONTAINER,IT SOAK
S INTO THE GROUND
6390 DATATOO DRY. FISH VANISH.,PIRATE AWAKENS. SAYS -AYE MATEY WE BE CASTING OFF
 SOON-
HE THEN VANISHES
,WHAT A WASTE...,I'VE NO CREW,PIRATE SAYS -AYE MATEY WE BE NEEDING A MAP FIRST-
6400 DATAAFTER A MONTH AT SEA WE SET ANCHOR OFF OF A SANDY BEACH.
 ALL ASHORE WHO'S GOING ASHORE...,TRY -WEIGH ANCHOR-,THERE'S A MAP IN IT,ITS A M
AP TO TREASURE ISLAND. AT THE BOTTOM IT SAYS
       -30 PACES AND THEN DIG!-
6410 DATA* WELCOME TO -PIRATES ADVENTURE- BY SCOTT & ALEXIS ADAMS *
,ITS EMPTY,I'VE NO PLANS!,OPEN IT?,GO THERE?,I FOUND SOMETHING!,I DIDN'T FIND AN
YTHING,I DON'T SEE IT HERE,OK I WALKED OFF 30 PACES.
6420 DATACONGRATULATIONS !!!
 BUT YOUR ADVENTURE IS NOT OVER YET...
,READING EXPANDS THE MIND,THE PARROT CRYS,-CHECK THE BAG MATEY-,-CHECK THE CHEST
 MATEY-,FROM THE OTHER SIDE!,OPEN THE BOOK!,THERE'S MULTIPLE EXITS HERE!
6430 DATACROCS EAT FISH AND LEAVE,I'M UNDERWATER. I CAN'T SWIM. BLUB BLUB...,-PI
```

Listing 1 continued on page 200



32K Board Pictured Above

Why Not the Best?

From The Dynamic RAM Company.

	2MHz	4MHz
16K	$249	$259
32K	$375	$395
48K	$500	$530
64K	$625	$665

We have now been shipping our 2MHz dynamic RAM boards for over two years. Hundreds of 4MHz boards have been going out every month since early 1979. Our reliability is proven in the thousands of systems which contain our board. Many quality-minded systems houses across the country and overseas are using our boards for their equipment.

Our prices still beat all. Despite rising 16K memory chip prices (at least from reputable suppliers), Central Data continues to give you the best buy in memory today. Nobody offers a board with a capacity of 64K, assembled, tested, and guaranteed for a full year at the price we do.

Deselect around PROMs. Our boards have the important deselect feature which lets you overlap any fixed memory in your system with no interference.

Our features make the board easily used and expanded. You address our boards on 16K boundaries with mini-jumps (small shorting plugs that slide over wire-wrap pins) near the top of the board for easy access. If you want to expand your board after you have purchased it, all that you need to do is add memory. We can supply you with expansion packages ($150-2MHz, $160-4MHz) which include eight RAMs that you can depend on as well as two mini-jumps for addressing. And of course, our board **never** generates wait states.

Low power consumption keeps your computer running cool and reliable. The total power consumption of our 16K board is typically less than 4 watts (+8V @ 300ma, +16V @ 150ma and −16V @ 20ma). Boards with additional memory typically increase power consumption only 1 watt per 16K!

Standard S-100 Interface. Our board is designed to interface with any standard S-100 CPU. All of the timing of the board is independent of the processor chip, and the board is set up for different processors by changing two plugs on the board.

Call or write us today. That will guarantee a fast response with more information on the board. Or make an order — you'll probably have the board in two weeks! **If you're interested, also ask for a catalog on our Z8000 16-bit processor board designed for the MULTIBUS.** All of these products are available to your local dealer, also.

Central Data Corporation, 713 Edgebrook Drive, PO Box 2530, Station A, Champaign, IL 61820. (217) 359-8010

Central Data

Circle 131 on inquiry card.

Listing 1 continued:

```
ECES OF EIGHT-,ITS STUCK IN THE SAND,USE 1 WORD,PIRATE SAYS -AYE MATEY WE BE WAI
TING FOR THE TIDE TO COME IN-,THE TIDE IS OUT,THE TIDE IS COMING IN
6440 DATAABOUT 20 POUNDS. TRY -SET SAIL-,-TIDES A CHANGING MATEY-,NOTE HERE -I B
E LIKING PARROTS. THEY BE SMART MATEY-,PIRATE FOLLOWS YOU ASHORE AS IF HE IS WAI
TING FOR SOMETHING.,FLIGHT OF STAIRS,1,OPEN WINDOW,2,BOOKS IN A BOOKCASE,2
6450 DATALARGE LEATHER BOUND BOOK/BOO/,0,BOOKCASE WITH A SECRET PASSAGE BEHIND I
T,0,PIRATE'S DUFFEL BAG/BAG/,4,SIGN ON WALL -RETURN TREASURES HERE. SAY SCORE-
SIGN BY STAIRS -ANTONYM OF LIGHT IS UNLIGHT-,1,EMPTY BOTTLE/BOT/,0
6460 DATAUNLIT TORCH/TOR/,4,LIT TORCH/TOR/,0,MATCHES/MAT/,0,SMALL SHIP'S KEEL AN
D MAST,6,WICKED LOOKING PIRATE,9,TREASURE CHEST/CHE/,9,MONGOOSE/MON/,8,RUSTY ANC
HOR/ANC/,24,GRASS SHACK,8,MEAN AND HUNGRY LOOKING CROCODILES,11,LOCKED DOOR,11
6470 DATAOPEN DOOR WITH HALL BEYOND,0,PILE OF SAILS/SAI/,17,FISH/FIS/,10,*DUBLEO
NS*/DUB/,25,DEADLY MAMBA SNAKES/SNA/,25,PARROT/PAR/,9,BOTTLE OF RUM/BOT/,1,RUG/R
UG/,0,RING OF KEYS/KEY/,0,OPEN TREASURE CHEST/CHE/,0,SET OF PLANS/PLA/,0,RUG,1
6480 DATACLAW HAMMER/HAM/,15,NAILS/NAI/,0,PILE OF PRECUT LUMBER/LUM/,17,TOOL SHE
D,17,LOCKED DOOR,16,OPEN DOOR WITH PIT BEYOND,0,PIRATE SHIP,0,ROCK WALL WITH NAR
ROW CRACK IN IT,18,NARROW CRACK IN THE ROCK,17,SALT WATER,10,SLEEPING PIRATE,0
6490 DATABOTTLE OF SALT WATER/BOT/,0,PIECES OF BROKEN RUM BOTTLES,4,NON-SKID SNE
AKES/SNE/,1,MAP/MAP/,0,SHOVEL/SHO/,15,MOULDY OLD BONES/BON/,0,SAND/SAN/,6,BOTTLE
S OF RUM/BOT/,0,*RARE OLD PRICELESS STAMPS*/STA/,0,LAGOON,6,THE TIDE IS OUT,24
6500 DATATHE TIDE IS COMING IN,0,WATER WINGS/WIN/,15,FLOTSAM AND JETSAM,0,MONAST
ARY,23,PLAIN WOODEN BOX/BOX/,0,DEAD SQUIRREL,0,,0,,0,
6510 REM
6520 REM PROGRAM STARTS HERE...
6530 REM
6540 CLEAR800:DEFINTA-Z:POKE 16553,255:RESTORE
6550 CLS:INPUT"PREPARE DATA TAPE (HIT ENTER)";TP$:D=-1
6560 CLS:PRINT@64*4,"ADVENTURE DATA TAPE BUILDER - WORKING"
6570 READ IL,CL,NL,RL,MX,R,TT,LN,LT,ML,TR:PRINT#D,IL,CL,NL,RL,MX,R,TT,LN,LT,ML,T
R
```

Listing 1 continued on page 202

Listing 1 continued:

```
6580 DIMCA(1,7),NV$(NL+10,1),IA$(IL),IA(IL),RS$(RL),RM(RL,5),MS$(ML),AA(5),A$(9)
,A(1,7)
6590 FORZ=0TOCL STEP2:FORXX=0TO1:FORY=0TO7:READ CA(XX,Y):NEXTY,XX:X=0
6600 Y=X+1:PRINT#D,CA(X,0),CA(X,1),CA(X,2),CA(X,3),CA(X,4),CA(X,5),CA(X,6),CA(X,
7),CA(Y,0),CA(Y,1),CA(Y,2),CA(Y,3),CA(Y,4),CA(Y,5),CA(Y,6),CA(Y,7):NEXTZ
6610 FORX=0TONL:FORY=0TO1:READ NV$(X,Y):NEXTY,X
6620 FORX=0TORL:READ RM(X,0),RM(X,1),RM(X,2),RM(X,3),RM(X,4),RM(X,5),RS$(X):NEXT
6630 FORX=0TOML:READ MS$(X):NEXT
6640 FORX=0TOIL:READ IA$(X),IA(X):NEXT
6650 FORX=0TONLSTEP10:FORY=0TO1:PRINT#D,NV$(X,Y),NV$(X+1,Y),NV$(X+2,Y),NV$(X+3,Y
),NV$(X+4,Y),NV$(X+5,Y),NV$(X+6,Y),NV$(X+7,Y),NV$(X+8,Y),NV$(X+9,Y):NEXTY,X
6660 FORX=0TORL:PRINT#D,RM(X,0),RM(X,1),RM(X,2),RM(X,3),RM(X,4),RM(X,5),RS$(X):N
EXT
6670 FORX=0TOML:PRINT#D,MS$(X):NEXT
6680 FORX=0TOIL:PRINT#D,IA$(X),IA(X):NEXT
6690 INPUT"REWIND TAPE TO BE VERFIED";TP$
6700 POKE16553,255:RESTORE:FORX=1TO11:READA0:NEXT
6710 INPUT#D,A0,A1,A2,A3,A4,A5,A6,A7,A8,A9,B0
6720 IFB0<>TRORA0<>ILORA1<>CLORA2<>NLORA3<>RLORA4<>MXORA5<>ROR(A6<>TT)ORA7<>LNOR
(A8<>LT)ORA9<>MLTHEN6790
6730 FORX=0TOCL STEP2:INPUT#D,A(0,0),A(0,1),A(0,2),A(0,3),A(0,4),A(0,5),A(0,6),A
(0,7),A(1,0),A(1,1),A(1,2),A(1,3),A(1,4),A(1,5),A(1,6),A(1,7)
6740 FORY=0TO1:FORZ=0TO7:POKE16553,255:READA0:IFA(Y,Z)<>A0THEN6790ELSENEXTZ,Y,X
6750 FORX=0TONLSTEP10:FORY=0TO1:INPUT#D,A$(0),A$(1),A$(2),A$(3),A$(4),A$(5),A$(6
),A$(7),A$(8),A$(9):FORZ=0TO9:IFNV$(X+Z,Y)<>A$(Z)THEN6790ELSENEXTZ,Y,X
6760 FORX=0TORL:INPUT#D,AA(0),AA(1),AA(2),AA(3),AA(4),AA(5),A$:FORY=0TO5:IFAA(Y)
<>RM(X,Y)ORA$<>RS$(X)THEN6790ELSENEXTY,X
6770 FORX=0TOML:INPUT#D,A$:IFA$<>MS$(X)THEN6790ELSENEXT
6780 FORX=0TOIL:INPUT#D,A$,AA(0):IFAA(0)<>IA(X)ORA$<>IA$(X)THEN6790ELSENEXTX:CLS
:PRINT"DATA TAPE VERIFIED":END
6790 PRINT"BAD TAPE!":END
```

Listing 2: *Main program of Scott Adams'* Pirate's Adventure *for the TRS-80. This program uses the data tape generated by listing 1.*

```
10 'COPYRIGHT SCOTT ADAMS. 1978
20 CLEAR5400:DEFINTA-Z:D=-1
30 IFD=-1IFMEM<>4526PRINT"BAD LOAD":END
40 X=Y=Z:K=R=V:N=LL=F:TP$=K$:W=IP=P:Z$="I'VE TOO MUCH TOO CARRY. TRY -TAKE INVEN
TORY-":GOSUB1240:GOTO100
50 CLS:PRINT"      ***   WELCOME TO ADVENTURE LAND. (#4.6) ***":PRINT:PRINT" UNLE
SS TOLD DIFFERENTLY YOU MUST FIND *TREASURES*
AND-RETURN-THEM-TO-THEIR-PROPER--PLACE!"
60 PRINT:PRINT"I'M YOUR PUPPET. GIVE ME ENGLISH COMMANDS THAT"
70 PRINT"CONSIST OF A NOUN AND VERB. SOME EXAMPLES...":PRINT:PRINT"TO FIND OUT W
HAT YOU'RE CARRYING YOU MIGHT SAY: TAKE INVENTORY
TO GO INTO A HOLE YOU MIGHT SAY: GO HOLE
TO SAVE CURRENT GAME: SAVE GAME"
80 PRINT:PRINT"YOU WILL AT TIMES NEED SPECIAL ITEMS TO DO THINGS, BUT I'M
SURE YOU'LL BE A GOOD ADVENTURER AND FIGURE THESE THINGS OUT."
90 PRINT:INPUT"      HAPPY ADVENTURING... HIT ENTER TO START";K$:CLS:RETURN
100 R=AR:LX=LT:DF=0:SF=0:INPUT"USE OLD 'SAVED' GAME";K$:IFLEFT$(K$,1)<>"Y"THEN13
0
110 IFD<>-1THENCLOSE:OPEN"I",D,SV$ELSEINPUT"READY SAVED TAPE";K$:PRINTINT(IL*5/6
0)+1;"MINUTES"
120 INPUT#D,SF,LX,DF,R:FORX=0TOIL:INPUT#D,IA(X):NEXT:IFD<>-1CLOSE
130 GOSUB50:GOSUB240:GOTO160
140 INPUT"TELL ME WHAT TO DO";TP$:PRINT:GOSUB170:IFFPRINT"YOU USE WORD(S) I DON'
T KNOW":GOTO140
150 GOSUB360:IFIA(9)=-1THENLX=LX-1:IFLX<0THENPRINT"LIGHT HAS RUN OUT":IA(9)=0ELS
EIFLX<25PRINT"LIGHT RUNS OUT IN";LX;"TURNS!"
160 NV(0)=0:GOSUB360:GOTO140
170 K=0:NT$(0)="":NT$(1)=""
```

Listing 2 continued on page 204

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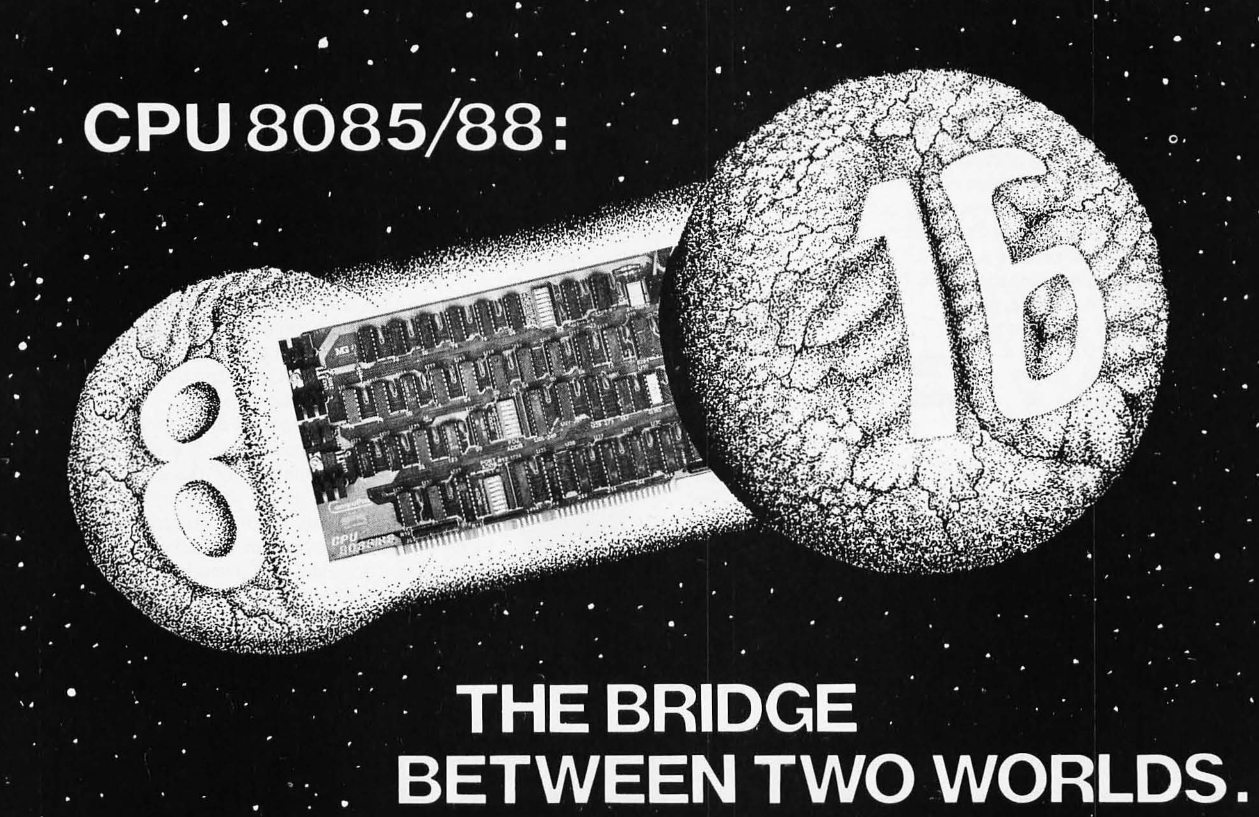
Circle 134 on inquiry card.

Listing 2 continued:

```
180 FORX=1TOLEN(TP$):K$=MID$(TP$,X,1):IFK$=" "THENK=1ELSENT$(K)=LEFT$(NT$(K)+K$,
LN)
190 NEXTX:FORX=0TO1:NV(X)=0:IFNT$(X)=""THEN230ELSEFORY=0TONL:K$=NV$(Y,X):IFLEFT$
(K$,1)="*"THENK$=MID$(K$,2)
200 IFX=1IFY<7THENK$=LEFT$(K$,LN)
210 IFNT$(X)=K$THENNV(X)=YELSENEXTY:GOTO230
220 IFLEFT$(NV$(NV(X),X),1)="*"THENNV(X)=NV(X)-1:GOTO220
230 NEXTX:F=NV(0)<1ORLEN(NT$(1))>0ANDNV(1)<1:RETURN
240 IFDFIFIA(9)<>-1ANDIA(9)<>RPRINT"I CAN'T SEE, ITS TOO DARK.":RETURN
250 K=-1:IFLEFT$(RS$(R),1)="*"THENPRINTMID$(RS$(R),2);ELSEPRINT"I'M IN A ";RS$(R
);
260 FORZ=0TOIL:IFKIFIA(Z)=RPRINT". VISIBLE ITEMS HERE:
":K=0
270 GOTO300
280 TP$=IA$(Z):IFRIGHT$(TP$,1)="/"FORW=LEN(TP$)-1TO1STEP-1:IFMID$(TP$,W,1)="/"TH
ENTP$=LEFT$(TP$,W-1)ELSENEXTW
290 RETURN
300 IFIA(Z)<>RTHEN320ELSEGOSUB280:IFPOS(0)+LEN(TP$)+3>63THENPRINT
310 PRINTTP$;".  ";
320 NEXT:PRINT
330 K=-1:FORZ=0TO5:IFKIFRM(R,Z)<>0PRINT"
OBVIOUS EXITS: ";:K=0
340 IFRM(R,Z)<>0PRINTNV$(Z+1,1);" ";
350 NEXT:PRINT:PRINT:RETURN
360 F2=-1:F=-1:F3=0:IFNV(0)=1ANDNV(1)<7THEN610ELSEFORX=0TOCL:V=CA(X,0)/150:IFNV(
0)=0IFV<>0RETURN
370 IFNV(0)<>VTHENNEXTX:GOTO990ELSEN=CA(X,0)-V*150
380 IFNV(0)=0THENF=0:IFRND(100)<=NTHEN400ELSENEXTX:GOTO990
390 IFN<>NV(1)ANDN<>0THENNEXTX:GOTO990
400 F2=-1:F=0:F3=-1:FORY=1TO5:W=CA(X,Y):LL=W/20:K=W-LL*20:F1=-1:ONK+1GOTO550,430
```

Listing 2 continued on page 208

CPU 8085/88:



THE BRIDGE BETWEEN TWO WORLDS.

When we shipped the first CPU 8085/88 back in June of 1980, we created a bridge between the 8 bit world of the present and the 16 bit world of the future.

The response has been overwhelming - but really, no other reaction would be appropriate for a CPU board that is downward compatible with 8 bit 8080/8085 software, upward compatible with 16 bit 8086/8088 software (as well as Intel's coming P-Series), designed for professional-level high speed applications, and engineered for full compliance with all IEEE 696/S-100 standards.

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Circle 137 on inquiry card.

Note: Unkits are not intended for novice builders. Assembly is simple, but de-bugging may be required due to problems such as IC infant mortality. In case of problems, factory service is available for unkits for a flat service charge.

CompuPro products are also available **assembled**, or qualified under our high-reliability Certified System Component (CSC) program (200 hour burn-in, extensive testing, 2 year extended warranty, more).

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COMPUPRO S-100 MOTHERBOARDS:
DESIGNED FOR THE FUTURE, AVAILABLE NOW

These advanced motherboards handle the coming generation of 5 to 10 MHz CPUs (as well as present day 2 and 4 MHz systems), and feature Faraday shielding between all bus signal lines to minimize crosstalk, active termination that splits the termination load between each end of every bus line, and mechanical compatibility with Godbout, Vector, Imsai, TEI, and similar enclosures. **Unkits** have edge connectors and termination resistors pre-soldered in place for easy assembly.

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#CK-024 20 slot motherboard with edge connectors - unkit $174, assm $214

COMPUPRO COMPUTER ENCLOSURE
$289 desktop, $329 rack mount

This handsome enclosure does justice to the finest computer systems. Includes dual AC outlets and fuseholder on rear, heavy-duty line filter, and black anodized front panel (with textured vinyl painted cover for desktop version). Pre-drilled base accepts our high-performance S-100 motherboards or types by Vector, California Digital, and others. Rack mount version includes slides for easy pull-out from rack for maintenance or board changing.

8088/8086 MONITOR DEBUGGER: $35

Supplied on single sided, single density, soft-sector 8" disc. CP/M* compatible. Great development tool; mnemonics used in debug conform as closely as possible to current CP/M* mnemonics.

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Active Terminator Board	$34.50 kit
Memory Manager Board	$59 unkit, $85 assm, $100 CSC
Mullen Extender Board	$59 kit
Mullen Relay/Opto-Isolator Control Board.	$129 kit, $179 assm
Spectrum color graphics board	$299 unkit, $399 assm, $449 CSC
2708 EPROM Board (2708s not included)	$85 unkit, $135 assm, $195 CSC
Interfacer 1 (dual RS-232 serial ports)	$199 unkit, $249 assm, $324 CSC
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Our current memory lineup features fully static design to eliminate dynamic timing problems, full IEEE 696/S-100 spec compatibility, 4/5 MHz operation, low power, extensive bypassing, and careful thermal design. CSC memories will run with 10 MHz CPU clock speeds on the S-100 buss (while drawing half the current of non-CSC boards) to give high speed, ultra-low power operation.

If you're looking for specs - if you're looking for performance - if you're looking for exceptional value, then look no further than the RAM series from **CompuPro**.

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16K RAM XX-16	$319	$399	$479
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OTHER S-100 MEMORY

	unkit	assm	CSC
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(Includes IEEE compatible extended addressing.)

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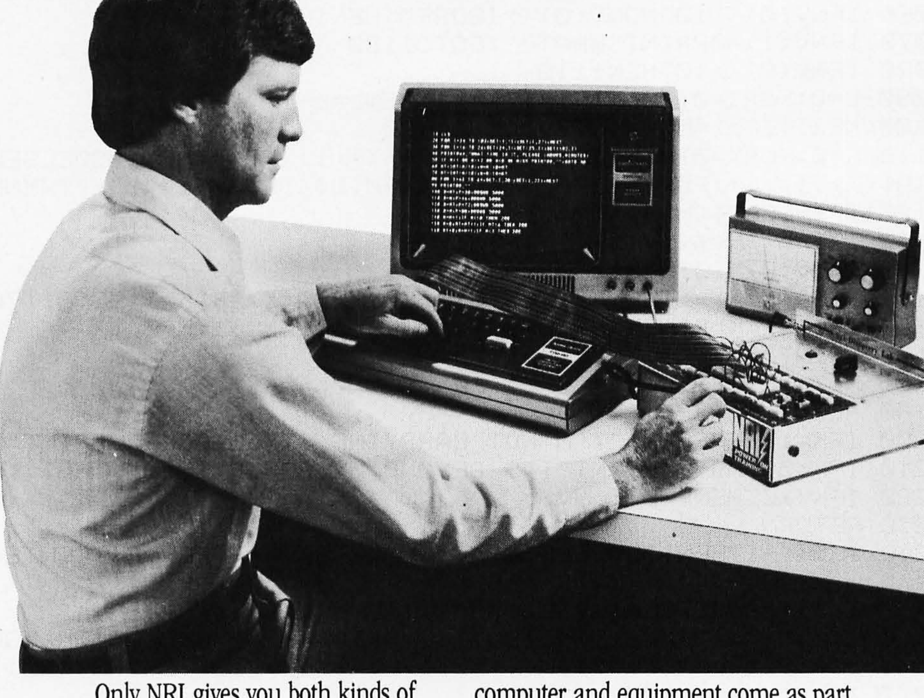
Circle 137 on inquiry card.

Listing 2 continued:

```
,450,470,490,500,510,520,530,540,410,420,440,460,480
410 F1=-1:FORZ=0TOIL:IFIA(Z)=-1THEN550ELSENEXT:F1=0:GOTO550
420 F1=0:FORZ=0TOIL:IFIA(Z)=-1THEN550ELSENEXT:F1=-1:GOTO550
430 F1=IA(LL)=-1:GOTO550
440 F1=IA(LL)<>-1ANDIA(LL)<>R:GOTO550
450 F1=IA(LL)=R:GOTO550
460 F1=IA(LL)<>0:GOTO550
470 F1=IA(LL)=RORIA(LL)=-1:GOTO550
480 F1=IA(LL)=0:GOTO550
490 F1=R=LL:GOTO550
500 F1=IA(LL)<>R:GOTO550
510 F1=IA(LL)<>-1:GOTO550
520 F1=R<>LL:GOTO550
530 F1=SFANDCINT(2↑LL+.5):F1=F1<>0:GOTO550
540 F1=SFANDCINT(2↑LL+.5):F1=F1=0:GOTO550
550 F2=F2ANDF1:IFF2THENNEXTYELSENEXTX:GOTO990
560 IP=0:FORY=1TO4:K=(Y-1)/2+6:ONYGOTO570,580,570,580
570 AC=CA(X,K)/150:GOTO590
580 AC=CA(X,K)-CINT(CA(X,K)/150)*150
590 IFAC>101THEN600ELSEIFAC=0THEN960ELSEIFAC<52THENPRINTMS$(AC):GOTO960:ELSEONAC
-51GOTO660,700,740,760,770,780,790,760,810,830,840,850,860,870,890,920,930,940,9
50,710,750
600 PRINTMS$(AC-50):GOTO960
610 L=DF:IFLTHENL=DFANDIA(9)<>R ANDIA(9)<>-1:IFL PRINT"DANGEROUS TO MOVE IN THE
DARK!"
620 IFNV(1)<1PRINT"GIVE ME A DIRECTION TOO.":GOTO1040
630 K=RM(R,NV(1)-1):IFK<1IFLTHENPRINT"I FELL DOWN AND BROKE MY NECK.":K=RL:DF=0:
ELSEPRINT"I CAN'T GO IN THAT DIRECTION":GOTO1040
640 IFNOTLCLS
650 R=K:GOSUB240:GOTO1040
660 L=0:FORZ=1TOIL:IFIA(Z)=-1LETL=L+1
670 NEXTZ
680 IFL>=MXPRINTZ$:GOTO970
690 GOSUB1050:IA(P)=-1:GOTO960
700 GOSUB1050:IA(P)=R:GOTO960
710 PRINT"SAVING GAME":IFD=-1THENINPUT"READY OUTPUT TAPE";K$:PRINTINT(IL*5/60)+1
;"MINUTES"ELSEOPEN"O",D,SV$
720 PRINT#D,SF,LX,DF,R:FORW=0TOIL:PRINT#D,IA(W):NEXT:IFD<>-1CLOSE
730 GOTO960
740 GOSUB1050:R=P:GOTO960
750 GOSUB1050:L=P:GOSUB1050:Z=IA(P):IA(P)=IA(L):IA(L)=Z:GOTO960
760 GOSUB1050:IA(P)=0:GOTO960
770 DF=-1:GOTO960
780 DF=0:GOTO960
790 GOSUB1050
800 SF=SF ORCINT(.5+2↑P):GOTO960
810 GOSUB1050
820 SF=SFANDNOTCINT(.5+2↑P):GOTO960
830 PRINT"I'M DEAD...":R=RL:DF=0:GOTO860
840 GOSUB1050:L=P:GOSUB1050:IA(L)=P:GOTO960
850 INPUT"THE GAME IS NOW OVER
ANOTHER GAME";K$:IFLEFT$(K$,1)="N"THENENDELSEFORX=0TOIL:IA(X)=I2(X):NEXT:GOTO100
860 GOSUB240:GOTO960
870 L=0:FORZ=1TOIL:IFIA(Z)=TRIFLEFT$(IA$(Z),1)="*"LETL=L+1
880 NEXTZ:PRINT"I'VE STORED";L;"TREASURES.
ON A SCALE OF 0 TO 100 THAT RATES A";CINT(L/TT*100):IFL=TTTHENPRINT"WELL DONE.":
GOTO850ELSE960
890 PRINT"I'M CARRYING:":K$="NOTHING":FORZ=0TOIL:IFIA(Z)<>-1THEN910ELSEGOSUB280:
IFLEN(TP$)+POS(0)>63PRINT
900 PRINTTP$;".",;:K$=""
910 NEXT:PRINTK$:GOTO960
920 P=0:GOTO800
930 P=0:GOTO820
940 LX=LT:IA(9)=-1:GOTO960
```

Listing 2 continued on page 210

Now NRI takes you inside the world's most popular microcomputer to train you at home as the new breed of computer specialist!



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Listing 2 continued:

```
 950 CLS:GOTO960
 960 NEXTY
 970 IFNV(0)<>0THEN990
 980 NEXTX
 990 '
1000 IFNV(0)=0THEN1040
1010 GOSUB1060
1020 IFFPRINT"I DON'T UNDERSTAND YOUR COMMAND":GOTO1040
1030 IFNOTF2PRINT"I CAN'T DO THAT YET":GOTO1040
1040 RETURN
1050 IP=IP+1:W=CA(X,IP):P=W/20:M=W-P*20:IFM<>0THEN1050ELSERETURN
1060 IFNV(0)<>10ANDNV(0)<>18ORF3THEN1230
1070 IFNV(1)=0PRINT"WHAT?":GOTO1180
1080 IFNV(0)<>10THEN1110
1090 L=0:FORZ=0TOIL:IFIA(Z)=-1THENL=L+1
1100 NEXT:IFL>=MXPRINTZ$:GOTO1180
1110 K=0:FORX=0TOIL:IFRIGHT$(IA$(X),1)<>"/"THEN1190ELSELL=LEN(IA$(X))-1:TP$=MID$
(IA$(X),1,LL):FORY=LLTO2STEP-1:IFMID$(TP$,Y,1)<>"/"THENNEXTY:GOTO1190
1120 TP$=LEFT$(MID$(TP$,Y+1),LN)
1130 IFTP$<>NV$(NV(1),1)THEN1190
1140 IFNV(0)=10THEN1160
1150 IFIA(X)<>-1THENK=1:GOTO1190ELSEIA(X)=R:K=3:GOTO1170
1160 IFIA(X)<>RTHENK=2:GOTO1190ELSEIA(X)=-1:K=3
1170 PRINT"OK, ";
1180 F=0:RETURN
1190 NEXTX
1200 IFK=1THENPRINT"I'M NOT CARRYING IT"ELSEIFK=2PRINT"I DON'T SEE IT HERE"
1210 IFK=0IFNOTF3PRINT"ITS BEYOND MY POWER TO DO THAT":F=0
1220 IFK<>0THENF=0
1230 RETURN
1240 IFD<>-1THEN1330ELSEINPUT"READY DATA TAPE.  HIT ENTER
";K$
1250 INPUT#D,IL,CL,NL,RL,MX,AR,TT,LN,LT,ML,TR
1260 W=(IL+CL/2+NL/10+RL+ML)/12:PRINTW+1;"MINUTES TO LOAD."
1270 DIMNV(1),CA(CL,7),NV$(NL,1),IA$(IL),IA(IL),RS$(RL),RM(RL,5),MS$(ML),NT$(1),
I2(IL)
1280 FORX=0TOCL STEP2:Y=X+1:INPUT#D,CA(X,0),CA(X,1),CA(X,2),CA(X,3),CA(X,4),CA(X
,5),CA(X,6),CA(X,7),CA(Y,0),CA(Y,1),CA(Y,2),CA(Y,3),CA(Y,4),CA(Y,5),CA(Y,6),CA(Y
,7):NEXT
1290 FORX=0TONLSTEP10:FORY=0TO1:INPUT#D,NV$(X,Y),NV$(X+1,Y),NV$(X+2,Y),NV$(X+3,Y
),NV$(X+4,Y),NV$(X+5,Y),NV$(X+6,Y),NV$(X+7,Y),NV$(X+8,Y),NV$(X+9,Y):NEXTY,X
1300 FORX=0TORL:INPUT#D,RM(X,0),RM(X,1),RM(X,2),RM(X,3),RM(X,4),RM(X,5),RS$(X):N
EXT
1310 FORX=0TOML:INPUT#D,MS$(X):NEXT
1320 FORX=0TOIL:INPUT#D,IA$(X),IA(X):I2(X)=IA(X):NEXT:IFD=-1RETURN
1330 REM
```



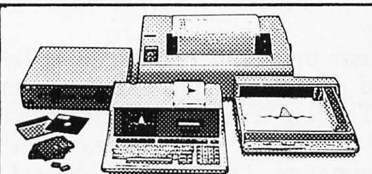
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Text continued from page 192:
bytes of memory, has the sole purpose of generating the Adventure-data file that will be read by the Adventure-interpreter program. The program of listing 1 writes the data on a C-60 cassette and verifies that the tape has been correctly written. Allow about 45 minutes for this program to run.

The Adventure-interpreter program appears in listing 2. It will read the tape data file in about 20 minutes and then start play of the game.

If you plan to run *Pirate's Adventure,* on a 32 K-byte TRS-80 or larger machine, you can merge the two programs as follows: delete lines 6510 thru 6790 of listing 1. Append the data statements of listing 1 to listing 2, replacing all occurrences of INPUT#D in listing 2 with the word READ.

It is possible to run this program on machines other than the TRS-80. If your machine runs a version of Microsoft BASIC (eg: Apple II running Applesoft, Commodore PET, Exidy Sorcerer, or any Ohio Scientific computer), you will have fewer changes to make. Here are some of the obscure changes that may have to be made (depending on your machine and version of BASIC):

- A logical operation returns the value −1 (or hexadecimal FF) when true, and 0 otherwise. For example, executing:

```
PRINT (1=2), (1=1)
```

causes the numbers 0 (denoting false) and −1 (denoting true) to be printed.

- The flag SF is a 16-bit integer that is set and tested with boolean algebra commands. This can be replaced by the following:

1. Dimension SF as SF(15)
2. Replace F1=SF AND CINT(2↑LL+.5) with F1=SF(LL)
3. Replace SF=SF OR CINT(2↑P+.5) with SF(P)= −1
4. Replace SF=SF AND NOT CINT(.5+2↑P) with SF(P)=0

- IF . . . THEN . . . ELSE statements in TRS-80 Level II BASIC assert that, if the condition being tested is true, the statements between the words THEN and ELSE are performed. If the condition is false, the statements following the ELSE are performed. If your BASIC does not have the ELSE clause, you will have to split the statement into multiple lines.
- LEFT(A$,B) returns the substring of A$ from the first character to the Bth character. Similarly, MID$(A$,B,C) returns the substring from the Bth character on, for a total of C characters, and RIGHT$(A$) returns the *last* (ie: rightmost) B characters in the string.
- If you cannot create a two-dimensional array of strings (eg: DIM A$(20,3)) as a twenty-row by three-column array of strings), you will find conversion nearly impossible because this feature is used heavily in the program.

Happy adventuring, and watch out for the tides on Pirate's Island—they can be tricky. ■

Please note that the Pirate's Adventure *is copyrighted. Its publication in BYTE entitles the reader to personal use only. The program may not be distributed in any way without the written permission of the author.*

BYTELINES

NEWS AND SPECULATION ABOUT PERSONAL COMPUTING

Conducted by Sol Libes

$299 Color Computer From Commodore: Commodore International Ltd has announced several new products, including the $299 VIC-20 color computer, which has been the subject of much speculation over the past year. The VIC (Video Interface Computer) connects to any television set or monitor and features color (22-character by 23-line display); sound; 5 K bytes of programmable memory (expandable to 32 K bytes); user-programmable function keys; full-size typewriter keyboard; high-resolution graphics; standard PET BASIC; a graphics character set; provisions for joysticks, paddles, and light pen; and external slots for extra memory and ROM (read-only memory) packs. Peripherals to be available include a tape-cassette unit, single floppy-disk drive, and printer. Commodore's new low-priced CBM 2031 single disk-drive unit (also part of the new products announcement) will be available in a serial-bus version for use with the VIC-20. The CBM 2031 will be able to store up to 170 K bytes on a single 5-inch floppy disk. It will retail for under $600.

Another significant announcement from Commodore was made with much less fanfare: a new, high-capacity business computer called the CBM 8096 that will feature an 80-column display, 96 K bytes of programmable memory, FORTRAN, COBOL, Ozz (Commodore's new user-adaptable data-management and retrieval program), and probably VisiCalc. It could have a dramatically low price. The CBM 8096 in conjunction with a high-capacity disk drive (like Commodore's new CBM 8062, with 3.2 megabytes capacity), could undersell the already low-priced Radio Shack Model II.

Availability: Do not expect to see the VIC-20 before the second quarter of 1981. The CBM 8096 will not be out before the fourth quarter of 1981.

Winchester 8-Inch Drives Off To Slow Start: Manufacturers of 8-inch miniature Winchester hard-disk drives are reporting that sales, so far, have been disappointing. Apparently there is a wait-and-see attitude on the part of customers. This appears to be due to standardization and interface problems, as well as the emergence of 5-inch miniature Winchester drives. Sales for 1980 were predicted to be in excess of 60,000 units; however, it appears that fewer than 37,000 will be shipped, with IBM taking a very sizable portion of this number.

Sales of 8-inch miniature Winchester drives are expected to increase at a healthy rate. Some industry analysts are predicting 500,000 units by 1985. It is further predicted that these drives will take over the 20- to 200-megabyte market previously held by 14-inch Winchester drives. It is expected that the 5-inch Winchester drives will dominate the under 20-megabyte market.

Model 33 Teletypewriter To Be Discontinued: The Teletype Corporation's Model 33 teletypewriter, affectionately known as "TTY" by long-time users, will be phased out of production by the end of 1981 after over twenty-five years of production. Teletype will also stop production on the models 28, 32, 35, DRPE, BRPE, and 4210. The Model 33 was the primary terminal for interactive computer use in the 1960s and early 1970s. Although it was designed for message transmission via telephone lines, early computer designers adopted it and its ASCII (American Standard Code for Information Interchange) character code as a standard. Parts and documentation support will be continued for five years.

DEC Shuts Two Computer Stores: DEC (Digital Equipment Corporation), the first computer company to open a chain of computer stores, has halted the planned expansion of its store network. Further, it has closed two of its twenty-seven stores. Reportedly, DEC spent between three and five million dollars to open the stores plus an equal amount for operating expenses, yet only a few of the stores have become profitable. The stores closed are in Detroit and the Wall Street district of New York City. More stores are expected to be shut down.

Xerox, CDC (Control Data Corporation), and Commodore all have followed DEC's lead by opening computer stores. Xerox expects to open fifteen stores in 1981, while CDC and Commodore stated that they expect to open "hundreds" of computer stores.

Reader's Digest Buys The Source: In a surprise move, the Reader's Digest has purchased a 51% interest in the Source Telecomputing Corporation. According to the *Washington Post*, Reader's Digest paid $3,000,000—a substantial amount of money for a company with no assets and only a marketing concept. The Source is entirely a resale operation: communications from Telenet, computing from a time-sharing service called Dialcomm, and data bases from all over. The *Washington Post* article also disclosed a messy court battle between Bill Von Meister, who developed the idea for The Source (and some years ago, developed the idea for the Mailgram), and Jack Taub, who ousted Von Meister in a financial power struggle last year.

A recent article in *Business Week* described The Source's woes. When Jack Taub took over the company last October, he immediately fired forty-five of the seventy employees, cut expenses, and procured additional financing. However, many suppliers

still report that they have not been paid and Taub had been asking them to wait until 1982.

The Source promised in its advertisements that airline schedules, restaurant guides in major cities, and mailgram-like services would be available. The mailgram went into effect last April and the airline schedules in June. The restaurant guide still covers only two cities. Also, at present a maximum of 100 users can use the system simultaneously; higher demand on The Source has led to some long-delayed responses.

Most users seem to accept The Source's problems as those of a pioneer with development difficulties and that slowly, but surely, the services are improving. Most agree that even with its problems, The Source is very worthwhile.

The Reader's Digest could be just what The Source needs to become successful. The purchase indicates that the Reader's Digest is clearly moving into the electronic journalism/communications/information field.

The Japanese Are Coming: Until now the US has dominated the micro-, mini-, and large-computer markets across the globe. However, things are changing and 1981 will no doubt see the Japanese as a major factor in the computer market. The Japanese are already pushing foreign computer suppliers out of the Japanese marketplace and are presently setting up marketing organizations in the US and Europe. They are moving slowly and very carefully, which is quite different from the American way of operating. Therefore, do not look for the Japanese computers to suddenly dominate the market. Rather, look for slow, but steady, growth as the Japanese learn how to adapt and market products in foreign marketplaces. There is no doubt that the hardware is first-rate—a congressional task force recently concluded that Japan has caught up to the US in semiconductor technology "and in certain areas, may be ahead of us." In fact, many American computer makers are already using Japanese components in their computers, and the trend is increasing.

This picture is essentially the same as that of the introduction of Japanese cars into this country. Japanese cars were first introduced in the US about 20 years ago. Today they account for 40% of the market. Their cars cost more than US cars but are designed and made better. The same thing will probably happen in the computer market. Who knows, in another ten years we may see government-supported loans for Apple, Commodore, or Radio Shack.

XENIX, UNIX-Like, UNIX-Equivalent—What Next? There are now at least three UNIX-like operating systems available for microcomputers, only one of which is licensed by Western Electric. By now, Microsoft should have its XENIX operating system, developed in the C language under Western Electric license. It will be available for Z8000-based systems. Electrolabs already has its "UNIX-Like" systems available for Z80-based systems, and Morrow Designs has announced a "UNIX-Equivalent" system for use with its Z80 system.

Microsoft claims that XENIX is to be a superset of UNIX and that it will conform to Release 7 of UNIX. Further, Microsoft hopes "to establish a clearinghouse for UNIX and XENIX software developed by users." XENIX will be sold primarily to OEMs (original equipment manufacturers), and Microsoft will receive $500 for each single-user copy sold.

Electrolabs claims that its OS-1 Operating System "appear[s] exactly like UNIX to the user" and that it "provides for up to 1024 users" plus "lots more"—all in 12 K bytes of code. A 4 K-byte CP/M adapter is also included (with source code) in the $249 price.

The Morrow operating system will be advertised as a "UNIX-Equivalent." It will be designed to run specifically with the new Morrow Z80 processor card, which includes a hardware mathematics processor and a programmable system-supervisor circuit for memory management.

Three-Dimensional System To Be Introduced: Genisco Computers, Costa Mesa, California, is expected soon to announce the first three-dimensional computer-graphics display. It will use a vibrating parabolic mirror and stroke display to create the illusion of a three-dimensional object hovering in space before the operator. The system will probably sell for about $100,000, and it is expected to find applications in air-traffic control, molecular research, and oil exploration.

Data Errors To Increase With Sunspots: NOAA (the National Oceanic and Atmospheric Administration) is predicting that increases in sunspot activity will cause disruption of data communications worldwide. This increase occurs every eleven years, with 1981 thru 1983 being a period of intense activity. The last such period occurred between 1969 and 1972. The effect is felt to be more severe at higher altitudes.

Double-Side Floppy Woes Persist: Makers of double-sided floppy-disk drives finally appear to be delivering reliable units. Users report that the 5-inch dual-sided drives exhibit excellent reliability. However, 8-inch drives still appear to have problems, and full production of high-reliability units is not expected for several more months. Experts are predicting that not until 1982 will we see a crossover point where more double-sided floppies are made than single-sided units.

Fired Programmer Sued For Erasing Programs: A suit filed by Leeds & Northrup (L & N) against a former employee accuses him of erasing several valuable programs shortly after being fired from his project manager/programmer position and before his password had been removed from the system. L & N is asking for $10,000 in damages and a court order restraining the former employee from future tampering with the computer. Fortunately, L & N was able to restore the obliterated programs from backup magnetic tapes.

Ups And Downs In Personal Computing: It's been all "ups" for Tandy Corporation, while it has been all "downs" for Texas Instruments (TI).

It looks like Tandy will sell close to 300,000 Radio Shack Model I computer systems by the year's end. Tandy reported that its fourth quarter earnings rose 52% to over $30 million, with year-end net sales of over $112 million. That's an increase of over 35%, on sales that rose 14%. Further, Tandy announced that it plans to open fifty more Radio Shack Computer Centers (there are sixty presently). Tandy also plans to have 250 full-line stores (ie: Radio Shack stores that carry its full microcomputer line of products) by the end of 1981. Also, 100 new Radio Shack stores will be added, bringing the total number of Radio Shack stores selling audio, electronic, and computer

equipment to 8000 worldwide.

Texas Instruments, on the other hand, has problems. Its 99/4 personal-computer system has met with poor sales, far less than TI projected. The general feeling is that, although the unit has many unique features, it is overpriced and undersupported. TI reported in its most recent quarterly report that this was one of the company's "adverse areas." But TI is not taking this lying down. Learning from automobile makers, TI is experimenting with $200 rebates ($100 cash and $100 worth of software) and is backing this up with promotion, software development, and a seminar program. The 99/4 lists at $950, but many dealers are discounting it to as low as $699 plus rebate.

Funny Bit: The Manhattan Yellow Pages telephone directory lists Lifeboat Associates, the country's largest distributor of microcomputer software, under "Marine Supplies & Emergency Equipment."

Tandy Introduces Three New Computers: Recently the Tandy Corporation announced three new personal computers. Their features have been covered in detail in several publications (see the October 1980 BYTE, page 172); there is no need to review them here. However, some comments may be worthwhile.

The three machines are the TRS-80 Color Computer, the TRS-80 Model III, and the TRS-80 Pocket Computer. The color computer sells for $400 in its basic configuration (4 K bytes of programmable memory) and is only expandable to 16 K. It uses the 6809processor and is therefore not compatible with the TRS-80 Model I and II. It does not look like it is intended to compete with the Apple computer. Rather, it appears aimed at competing with lower-level systems such as the Atari 400 and TI-99/4 personal computers.

Although Tandy denies it, the Model III appears to be a replacement for the Model I. Considering that the Model III contains the monitor, keyboard and disk drives in a single enclosure, is software compatible with the Model I, and offers additional enhancements, most industry people feel that the Model I will be phased out when the Model III systems finally arrive at the stores.

The Pocket Computer is really a marketing experiment. Neither Tandy nor any of the other pocket-computer makers really know if there is a meaningful market for this machine. Quasar and Panasonic talk about selling one million of their new hand-held computers next year (at $400 each). Tandy, however, is selling its at $250 and may garner the major portion of the market.

But what is the market for these pocket machines? The makers are projecting that they will be bought by salesmen and executives who, via a modem, will contact their home computers to book orders, check order status, receive and send messages, etc. Will hobbyists be attracted to these machines? The successful systems today all have a strong hobbyist base. It will, therefore, be interesting to see if these pocket devices catch on as planned.

TRS-80 Copy Due From Far East: EACA Limited of Hong Kong is manufacturing a functional copy of the Radio Shack TRS-80, which is no doubt the most popular microcomputer system made to date. Although it does not look like a TRS-80, it is hardware and software compatible with it. The computer will be marketed in the US by Personal Micro Computers Inc (PMC), Mountain View, California, and will be known as the PMC-80. It will list for $595 (without a monitor), which is $200 less than the TRS-80. It will have a 50-pin bus (TRS-80 has a 40-pin bus); PMC plans S-100 and TRS-80 interfaces.

Random Rumor Bits: Zilog is still having problems delivering bug-free Z8000 chips.... AMD (Advanced Micro Devices) is rumored to be working on the Z8003, a 32-bit version of the Z8000, scheduled for release in 1981.... NEC is rumored to be about ready to announce a new video-display-controller integrated circuit capable of handling a bit-map graphics display of 1024 by 1024 pixels, devoting 16 bits to each pixel. It will be capable of being configured for gray scale or color (3 bits each for red, green, and blue intensities) and still have 7 bits left over for things like blinking pixels, intensity protection, etc.... Intel, Western Digital, National Semiconductor, and Texas Instruments are all rumored to be working on controllers for Winchester floppy-disk systems. When these integrated circuits are available, it should reduce the cost of these controllers from the present $1000 to $1500 to a range of $200 to $500....

Random News Bits: SofTech MicroSystems Inc, sole licensing agent for UCSD Pascal, expects to make available a 16-bit version of UCSD Pascal for 8086-based systems sometime in 1981. This will be followed later by a 68000 version.... Tandy Corporation (parent of Radio Shack) has acquired the Lika Corporation of Stockton, California, for $4.5 million. Lika is a manufacturer of double-sided and multilayer printed-circuit boards.... Apple is having difficulty shipping Apple IIIs and does not expect the first shipments until after the first of the year, six months later than promised.... Bubble-memory prices are dropping as yields improve. Intel has dropped the price of its BPK bubble-memory prototyping kit from $1710 to $995 and its iSBC250 bubble-memory card from $4750 to $3500. Sales of bubble memories rose to $226 million in 1980 compared to $18.4 million in 1979.... National Semiconductor has introduced a microprocessor with BASIC in ROM (read-only memory). The INS8073 device has a 2.5 K-byte ROM with Tiny BASIC and a 64-byte area of programmable memory, which is used as a scratch-pad memory.... ANSI (American National Standards Institute) has established a committee to develop an APL language standard. Those wishing to participate should contact Clark Wiedman, University of Massachusetts Computing Center, Amherst MA 01003.... Shugart Associates will soon introduce a new series of 5-inch floppy drives capable of storing 500 K bytes on a single side and 1 megabyte on two sides. They will be compatible with older drives.... IBM is quietly setting up a distributor organization to sell its computer peripherals.... The Massachusetts Department of Revenue recently held hearings on a new tax for off-the-shelf software, time-sharing, and other data-processing services.... Apple Computer will soon begin production of the new Apple III in a new plant located in Ireland.

MAIL: I receive a large number of letters each month as a result of this column. If you write to me and wish a response, please include a stamped, self-addressed envelope.

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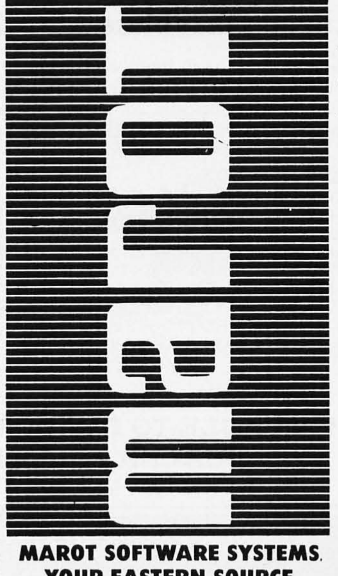
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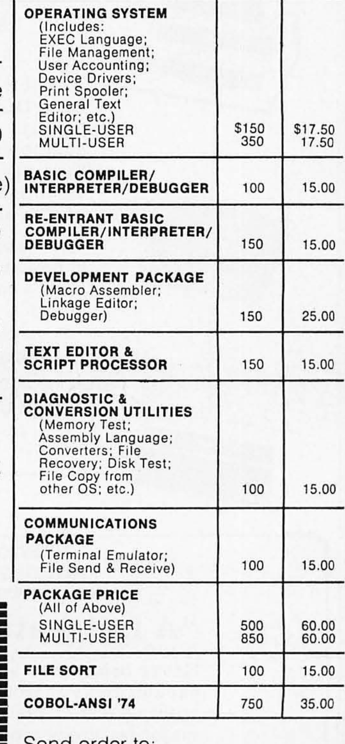
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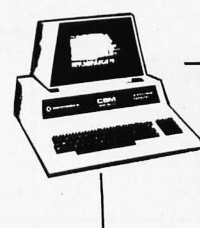
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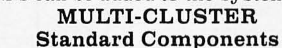
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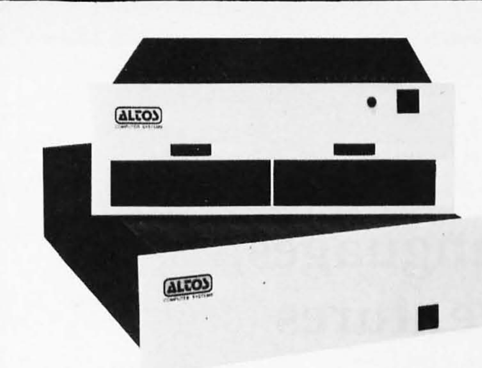
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BASIC, Computer Languages, and Computer Adventures

Jerry Pournelle
c/o BYTE Publications
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It's a typical Sunday afternoon here at Chaos Manor. In one room a dozen kids are playing games on the Radio Shack TRS-80, while here in the office I've been playing about with the C programming language after adding a check-writer to my accounting programs. My wife, the only practical member of the family, gently reminds me of my deadlines: galley proofs of a new novel, *King David's Spaceship* (Simon and Schuster); two chapters of the latest Niven/Pournelle collaboration, *Oath of Fealty* (Simon and Schuster, Real Soon Now); plus three columns; a speech to a librarians' convention; and inputs for a NASA study on America's fifty-year space plan. Some business people worry about cash flow; for authors it's work flow—work comes in bunches, like bananas, and sometimes it seems everything has to be done at once.

So, since it's what we've been doing here lately, I'll talk about computer games and programming languages; a disparate set of topics, but not quite as unconnected as they might seem at first glance.

Languages

One of the biggest unsolved problems in the microcomputer field is languages: which ones are going to be standard? Everyone learns BASIC, of course, because it comes with the machine, and it's a very easy language to learn. Pretty soon, though, you come to the limits of the BASIC supplied with the computer; and then what?

A few years ago there wasn't a lot of choice. You could buy FORTRAN, and perhaps COBOL; you could learn assembler; but then you were stuck. Moreover, there didn't seem to be any obvious advantages to FORTRAN and COBOL, both of which were not only hard to learn, but also difficult to connect up with the computer. Most of the books on those languages were written with big mainframe machines in mind, and the documentation for the small-system versions was, to put it kindly, rather skimpy. Moreover, the user manuals were filled with mysterious references to "logical devices" and other such nonsense, while giving almost no clear examples of how to get programs running on a home computer.

The result was a great expansion of BASICs. What was once a simple teaching language, designed largely to let new users become familiar with the way computers think, became studded with features. Every time you turned around there was a new BASIC interpreter, each one larger than the last, and almost none of them compatible with each other. Whatever portability BASIC had enjoyed vanished in a myriad of disk operations, functions, WHILE statements, new input formats, etc, etc, and, at the same time, the "free" memory left over after loading BASIC got so small that you couldn't handle much data.

The logical end of that process is Microsoft's newest BASIC-80. Understand, it's an excellent BASIC. It has features that, not long ago, the most advanced languages didn't have. It's well documented—at least the commands and functions, which are listed alphabetically, are clearly described. The general information section could be expanded with profit—at present it's written for users who are already more or less familiar with how BASIC operates. There are elaborate procedures for error trapping, and they all work. The editor has been improved. There are procedures (not very well documented) for linking in assembly-language subroutines. You can use long variable names, such as "Personal.data.1" and "Personal.data.2", and be certain the program will know they are different variables.

In other words, there's a lot going for it; but it takes up 24 K bytes of memory, and it's still BASIC. If you want to understand your program six weeks after you write it, you'll have to put in a lot of REMark statements, every one of which takes up memory space. As with all BASICs, you have to sweat blood to write well-structured code (and if you don't bother, that will come back to haunt you when you want to modify the program). And, like all BASICs, it is *slow*. Fairly simple sorts, even with efficient algorithms, take minutes; disk operations are tedious.

I suspect that Microsoft BASIC-80 is the end of the line; they have carried BASIC about as far as it can go. They've done it very well, but they've also reached the inherent limits of the language; and those limits may not be acceptable.

Of course most programmers have always known that

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even the best BASIC interpreter wasn't good enough; that if you add enough features to make the language useful, you'll end up with a very slow monster that takes up far too much memory, and that even if you could tolerate those limits, the language itself forces sloppy thinking and inelegant code. However, knowing the problem didn't make the solution obvious; indeed, it's not obvious yet. We can recognize the limits to BASIC and still not agree on what to do about it.

There seem to be two fundamental paths. One is to start over: to relegate BASIC to its original function as a teaching language, and switch to some other language for serious programming. Many took this path, and came out with microcomputer versions of such languages as C, APL, ALGOL, LISP, FORTH, STOIC, and Pascal.

The other way is to *compile* BASIC. One of the first compiled BASICs, BASIC E, is in the public domain; I obtained a fairly decent version with (barely) adequate documentation from the CP/M User's Group several years ago. Then Software Systems brought out an improved BASIC E called CBASIC. It is easy to use and features really excellent documentation, some of the best I've ever seen. It has decent file structures; you are not limited to either *sequential* or *random-access* disk files, but may use sequential operations on random-access files.

There are irritants in CBASIC, particularly with regard to line-printer operations. CBASIC has only the PRINT and PRINT USING commands; there is no LPRINT. To get hard copy, you must execute a LINEPRINTER statement, then one or more PRINT statements, then do a CONSOLE statement to have the copy sent to the terminal. Every time you do the CONSOLE statement, the print buffer empties, and you can get unwanted stuff printed on your hard copy; worse, you can also get unwanted line feeds, making it tough to format hard copy (although CBASIC does allow you to output characters through a port so that, if you are clever enough, you can control the line printer directly; you could even make a CBASIC program drive a Diablo for reverse printing if you wanted to spend the time writing that program). Another needless limitation is that CBASIC allows a maximum carriage width of 133 characters, although a 12-character-per-inch printer can print lines 158 characters long.

Irritants or no, CBASIC is both well designed and well documented. It has WHILE; IF-THEN-ELSE (with chaining); long variable names; and logical operations (IF TAX >0 AND PRICE < MAXIMUM.ACCEPTABLE THEN GOSUB 234 ELSE PRINT "NO GOOD" is a perfectly valid CBASIC expression). It has the CASE (Switch or ON-GOTO) statement.

And it saves memory by compiling. To use CBASIC, one creates a program with any editor that makes ASCII (American Standard Code for Information Interchange) files (Electric-Pencil-created programs have to be put through a converter), then turns the CBASIC compiler loose on it. What comes out isn't true compilation; the compiler strips out remarks and needless line numbers, and compacts the remainder into an INT (intermediate) file; when you want to run the program, you must load in a 10 K-byte run-time package. The INT file is still interpreted; it is not a machine-language program. You can, though, include scads of remarks, put each statement on a separate line, leave lots of blank space, put in rows of asterisks, indent whole sections of the program, and thus vastly increase program readability without using up memory space. A CBASIC program can be written for legibility.

But it's still BASIC. Because a program *can* be reasonably well structured and self-documenting doesn't mean that it will be; BASIC makes it easy to write incomprehensible code and difficult not to. And CBASIC is *very slow*, no faster than Microsoft BASIC-80 and often slower.

There's another limit. It's very hard to write long programs in CBASIC. This problem is inherent in any compiled language—whether true compilation to machine code, or pseudocompiling to an INT file. For example, assume that I want to add a small feature to my accounting package (which I did in fact write in CBASIC two years ago). I load the source program into the text editor. I add the feature and hook it into the program; since I do sweat blood to write structured code, that's fairly easy. Now I must save the altered source and put it through the compiler. Since it's a long program, the compilation takes many minutes—and toward the end, I get a SYNTAX ERROR message. I've put a comma where it wants a semicolon.

Now I have to load the editor, read in the source, make the change, save, and recompile. Presuming that this time it goes without error, I may have used up half an hour just to change "," to ";"—and I still have no test of the program's *logic*. If I now test for logic and it's not right, well, I have to start all over again, hoping that this time I don't manage a new syntax error....

Thus, you can use up a whole afternoon adding something quite simple to a big program. There must be a better way. Why can't someone come up with a language that runs interpretively like normal BASIC, letting you correct both syntax and logic errors while in an interactive mode; and then allow you to compile the result? While we're at it, let's wish for the compiled program to be in true machine language, code that could be put into read-only memory, and, moreover, code that would be *fast*.

That's the route that Microsoft took. Their BASCOM compiler works just that way with their BASIC-80. It will also compile Microsoft BASIC 4.5, and, with considerable modifications to syntax, programs written in both CBASIC and BASIC E. Moreover, it's a very powerful compiler. It implements almost all the features of BASIC-80, including WHILE, IF-THEN-ELSE, CASE, logicals, and string operations, etc. It sounds like the answer to a prayer.

Of course there are problems. Random-access disk operations are unbelievably messy, and worse, a random-access file cannot be accessed sequentially. There's considerable overhead burden. For example, this program:

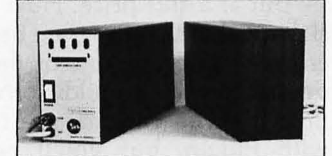
```
10 PRINT "Hello"
20 END
```

required 9 K bytes when compiled into a CP/M COM file; there's obviously a big run-time package built into BASCOM. Worse, present Microsoft user contracts require that anyone marketing a program compiled by

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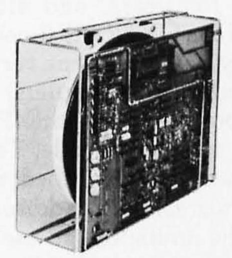
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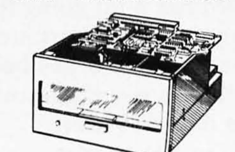
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BASCOM pay a stiff 9% royalty to Microsoft on every *copy sold!* Since this is about equal to the profit margin of many software houses, it's understandable that there's been no great rush to sell programs employing BASCOM.

But let's assume much of this is fixed. Microsoft has a good reputation for responding to customer suggestions. As an example, at the West Coast Computer Faire I spoke to the Microsoft representatives about the lack of a FILES statement (a means of finding out the file names present on disk) in BASCOM; BASIC-80 supported FILES, but not the compiler. Two weeks later I received an updated version of BASCOM—and lo!—the FILES statement had been implemented, along with several features other users had suggested.

At the National Computer Conference, Microsoft representatives said they were "rethinking" their contract policy and would probably change it; that change may have been implemented by the time you read this. I have also mentioned to them the desirability of allowing sequential access to random files, and they've promised to look into that. It's not unreasonable to assume they'll tighten up the overhead-code problem. Thus, as I said, let's assume that the major problems of BASCOM are fixed. What will we have?

First, the combination of BASIC-80 and BASCOM is superb for quick and dirty jobs and for those little special-purpose programs that aren't going to be run very often (possibly only once). For example, I recently wanted to reformat some financial data files. The program had to go open the file, read the data, make a couple of changes, and write the information out in a new format. The only problem was that I also wanted to sort the data before putting it back out, and this had to be done for a *lot* of files. Doing it with interpretive BASIC would take hours and hours; while writing even that simple a program in Z80 assembler would, at best, use up an afternoon, and might take a lot longer.

The solution was to write it in BASIC-80, test syntax and logic while in interpretive mode, and compile with BASCOM. That took an hour. In another hour, I had reformatted about one hundred files. BASCOM is fast, blindingly fast; sorts that take 3.5 minutes in CBASIC are done by BASCOM (using the same algorithm) in under 20 seconds.

In other words, the combination of BASIC-80 and BASCOM has a *lot* going for it. If I'd written this review a year ago, I'd have concluded that BASIC-80/BASCOM was what the world has been waiting for, and spent the rest of the review suggesting incremental improvements to make it even better.

Now I'm not so sure.

The problem is that when all the improvements are done; when all the bugs (if any; I've found none in the latest versions of BASCOM) are eliminated; when all the new features are added; when the code is tightened; when the disk operations are simplified—when all that's done, it's still BASIC.

And there are many who believe BASIC is a dead end; that the inherent limits to the language are just too severe for it ever to be acceptable; that incremental improvements actually harm rather than help the field, because they encourage newcomers to stick with BASIC instead of learning something better. My mad friend is convinced of that. So are a number of my associates.

"But," I protested to my mad friend, "I'm interested in *using* computers. I don't *care* about elegance. What I want is something that lets me get the jobs done quickly, and BASIC-80/BASCOM does that...."

"But at a stiff price. How many times have you had to start over with a program because it just wasn't worth the effort to improve one of those BASIC routines? BASIC doesn't let you build software tools. It's like Pidgin English—you can manage to buy dinner and sell copra with Pidgin, but you'll never write *Hamlet*. Or the Declaration of Independence, or even good laws...."

And the argument starts over and goes on until we get hungry, and, at the bottom line, it's all a matter of opinion; and since my space is limited, I'll drop it for the moment. Just now the bottom line is that BASIC-80 and BASCOM work, and, if you're willing to accept the inherent limits of BASIC, they're quite splendid; but those limits are severe.

Looking Elsewhere

What, then, are the microcomputer user's best alternatives to BASIC? Once again, let me be honest: these are opinions. They're opinions based on considerable user experience, but they're opinions still; and I have found that every known language has passionate supporters, so I am bound to make someone unhappy.

The earliest alternatives to BASIC were FORTRAN and COBOL. These, in my judgment, are languages whose time has long passed. They have little to recommend them, because they have nearly all the limits of compiled BASIC without the advantage of letting you program in the interpretive mode before compiling. I've had both for years, and after an initial flurry of enthusiasm for FORTRAN (I never cared at all for COBOL, which may be all right for very large systems, but is plain crippled on microcomputers) they went on the shelf and haven't come off it. Neither FORTRAN nor COBOL lets you write structured code. True, FORTRAN with RATFOR (excellently described in Kernigan and Plauger's book *Software Tools*, Addison-Wesley, 1976) overcomes some of the limits; but to use RATFOR requires *another* compilation stage, so that it can take over an hour to find and correct a trivial error in a fairly simple program. The *Software Tools* approach to programming is excellent, and I strongly recommend the book; but in my judgment the deficiencies of FORTRAN with RATFOR are simply overwhelming, and I cannot recommend using them.

Then there's Pascal, which very well may be the wave of the future. Pascal began unfortunately: the first widespread implementation of Pascal for microcomputers was from the University of California, San Diego, and it just didn't work for most users. The hooks into the disk operating system were clumsy, and it was *very slow*.

Then came some other versions of Pascal, and they too had horrible problems; you had to be really sophisticated to use them. Bugs appeared, and, unless you knew an awful lot, you couldn't tell whether you'd made a program error or the compiler was at fault. Implementing early Pascals required a constant and fairly complex dialogue between user and publisher.

As a result, a lot of us lost interest in Pascal. The language looked great in theory, but if you couldn't run it, that hardly mattered.

There are now a lot of Pascals; Pascal for the Apple, Pascal for the TRS-80, Pascal for CP/M; Pascal that

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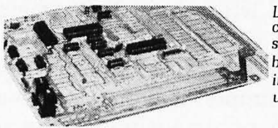
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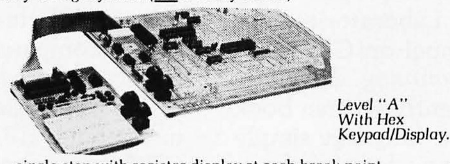
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pseudocompiles to an INT file the way CBASIC does (Pascal users call the INT file "p-code"); Pascal that truly compiles into machine language for 8080, Z80, 8086, etc. All these look good, and people I respect tell me they run; but since I haven't implemented any of them yet, I can't report on them. I can say that Pascal has many enthusiasts, and might well be the standard language of the future. Then there's Ada, a Pascal-like language heavily supported by the DOD (Department of Defense), which will certainly be around for many years. If I were preparing for a secure career in programming, I'd learn Pascal instantly and keep very close tabs on the progress of Ada.

In the next couple of months, we're adding a Pascal expert to the staff here, and I'll devote a whole column to Pascal/Ada; for now, I must simply pass them over.

Pascal has enthusiasts. So does C, a programming language developed at Bell Telephone Laboratories. The best (and indeed nearly the only) manual on C is Kernighan and Ritchie's, *The C Programming Language* (Prentice-Hall, 1978). This is an excellently written book which anyone at all interested in the C language simply must read. It succeeds in communicating a lot of enthusiasm for C. There are lots of examples of real programs that work. Kernighan, incidentally, is the same Brian Kernighan who coauthored *Software Tools*.

C is nothing like BASIC. There are far fewer commands, for one thing. On the other hand, there are a number of conventions. For example, the BASIC statements:

```
FOR I = 0 TO N - 1
NEXT I
```

would appear in C as:

```
for ( i = 0; i < N; i++)
```

which looks complex, but is, with a bit of experience, quite readable. The i++ means that i is first to be tested against N, then incremented; the expression could have been written with ++i, which would require that i be incremented *before* the test against N.

Despite (perhaps because of) the numerous time-saving conventions such as ++i, C can be learned by a BASIC user in a couple of weeks. Real facility requires practice; more practice than BASIC, precisely because there are many fewer limits in C. Programming with elegance and style takes work—but in C such programs are possible, while BASIC simply won't let you write elegant code.

I have two C compilers for microcomputers. I'm told there's also an interactive tiny-c, which I have not seen running, but which is said to be a good teaching aid, although severely limited in capability. [**Editor's note:** *See "A User's Look at Tiny-c," by Christopher O Kern, December 1979 BYTE, page 196....***RSS**]

Of my two C compilers, only one is suitable for those not already familiar with the C language. This is BDS C, available from Lifeboat Associates for $125. BDS C comes with a copy of Kernighan and Ritchie's book and quite extensive documentation on the BDS (BD Software) implementation.

The BDS compiler uses two passes. One might at first think that a disadvantage because of the time required, but in fact it is not: the first pass is done *very* fast, and checks for trivial errors, such as missing semicolons, comments improperly delimited, unmatched parentheses and brackets (C *loves* brackets, braces, and parentheses), and the like. The second pass goes a bit slower but is still much faster than the CBASIC compiler.

Like BASCOM, compiled C code must be put through a linker, and like Microsoft's, the BDS documentation tells you precisely how to do this. When it's all finished, you have a CP/M command file; and the resulting code is *very* fast. I've not yet been able to benchmark BDS C against a similar BASCOM program, because when you translate from BASIC to C you actually restructure the program; but I have two *Othello* games, one in C and the other compiled by BASCOM, and they seem to run at about the same speed. The C program, however, is about 8 K bytes compiled; the BASIC program, performing the same searches and playing at the same level, compiled to over 20 K bytes. Other programs doing similar jobs also run in comparable times, and with about the same differences in program size.

Disk operations in BDS C are fairly simple if you understand CP/M, not so simple if you don't—and CP/M's documentation is so notoriously unclear that you'll have to work for a couple of days understanding CP/M before you can write decent disk I/O (input/output) operations for BDS C. It is worth sharpening up your understanding of CP/M, though, because BDS C lets you do *everything* CP/M will: get the names and sizes of files currently on disk, make backups, rename and delete, etc, and it's no more difficult to understand than the FIELD statements in Microsoft BASIC or the dreaded FORMAT statement in FORTRAN.

String operations in C are more difficult than in BASIC. Actually, they aren't; ie: it's possible to write, in C, all the string functions of BASIC (such as LEFT$, etc), then call them as needed; and once you have written them, you can use them in any program that needs them —and leave them out if not wanted. And, in fact, that illustrates one of the fundamental differences between BASIC and C: the BASIC language provides a number of functions which you must have present whether you need them or not, and which must be used *exactly* the way BASIC wants them used. C, on the other hand, allows you to leave out functions you don't want, and rewrite those you keep to suit your precise requirements.

There is, however, one very severe limit to BDS C: it does not support floating-point data types. One can use floating-point *variables*, because BDS supplies a number of functions that can be called to do floating-point arithmetic; but the result is clumsy. If you want to learn the C language, and write games, calendar programs, and almost anything that doesn't involve crunching a lot of numbers, BDS C is highly recommended; however, it isn't suitable for writing an accounting or financial package.

The other C compiler for microcomputers is the Whitesmiths C Compiler, which is available from Lifeboat Associates for $630. This is a full implementation of the standard C described by Kernighan and Ritchie, and is highly regarded by many professionals who work with large machines like DEC's (Digital Equipment Corporation) PDP-11. In fact, Whitesmiths C was written for large machines, and it is only an accident that it could be scaled down for microcomputers. The president of Whitesmiths Ltd is P J Plauger, a fellow science fiction writer, and more important, coauthor of *Software Tools*.

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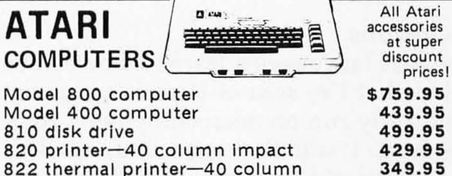
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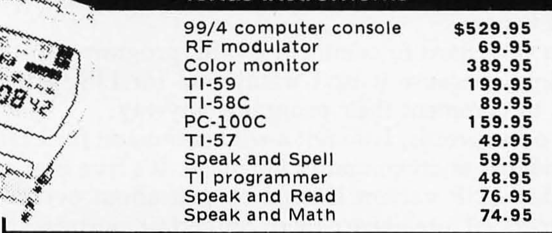
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Although the Whitesmiths Compiler is an excellent professional tool, I cannot recommend it to anyone who doesn't intend to program in C in a big way—and even then I'd recommend buying the BDS C compiler as well. Whitesmiths C compiles, eventually, to true machine code; *but it* does so by going through an intermediate assembly language called A-Natural. It's slow, and since there's no first pass to find trivial errors, the Whitesmiths compiler can grind away for half an hour before reporting a misplaced semicolon. It is certainly not what I'd choose to learn the language with—but I would get it if I were going to market programs written in C.

Ubiquitous Microsoft doesn't market a C compiler, but it does have a LISP interpreter. The Microsoft muLISP-79 is well done, if you like the LISP language. You may not care for the language, but those who like it like it a lot. LISP stands for list processing, and it makes creating highly complex linked lists very easy.

LISP is, however, a peculiar language. It was written in the 1950s by Dr John McCarthy, now Director of the Stanford Artificial Intelligence Laboratories (SAIL), and it's extensively used at Stanford and MIT (where McCarthy wrote it).

LISP does bit-by-bit arithmetic, meaning that there is no theoretical limit to the precision you can obtain; if you want an exact numerical expansion of, say, 2 to the 55th power, or 87 factorial, you can get it from LISP, and with only about three lines of code for a program—and you'll get the answer faster than you think. LISP is one of the fastest languages I know of, often approaching assembly-language programs in speed of operation.

LISP programs are very tight; it's almost impossible to write unstructured code in LISP. It's also very nearly impossible to understand a LISP program, even if you wrote it; at least that's been my experience. You can strain like a gearbox and produce code that runs, and which you understand just at that moment; but hours later it's gibberish. The only thing less comprehensible than a LISP program is one in APL—APL doesn't even use normal letters, but instead requires a special keyboard that can generate strangely bent arrows and other weird symbols. Both LISP and APL programmers delight in writing a whole page of instructions into one line (and you can do it, too, because both languages allow functions to call themselves). They also like to baffle fellow professionals by showing a line of code and challenging anyone to say what it does.

It's very hard to comment a LISP program—but that's all right, because it isn't traditional for LISP programmers to comment their programs anyway.

In other words, I am not a wild enthusiast for LISP as a "standard" microcomputer language. It's true that one or another LISP variant is used by just about everyone in the artificial intelligence field; for certain purposes there's nothing better. But for general-purpose programming, LISP and APL are, in my judgment, simply too obscure.

The Microsoft muLISP-79 was written by The Soft Warehouse in Hawaii; I got mine directly from the authors and haven't seen the Microsoft versions (for CP/M and the TRS-80), although they were supposed to be sent weeks ago. I am told that Microsoft has rewritten some of the documentation, which could only improve it. The problem with documenting LISP is that the language is fairly obscure; you need not only a user's manual, but an introduction to LISP itself, which is far more than the muLISP-79 manual claims to be.

The best way to learn LISP is to attend Stanford or MIT and get tutorial instruction from someone already proficient. The next best way is to get access to the MIT Macsyma Consortium computer and run the TEACH-LISP programs. There are also a couple of MIT documents which are pretty good introductions. I wish I knew of a good commercial textbook, but I don't. If you want to learn LISP, you've no choice but to play about with it; since muLISP-79 is interactive, that's not so hard to do, and there are some decent examples in the documents suppied. If you like playing with powerful languages, muLISP-79 is recommended—but don't blame me if you don't use it very often after the first wave of enthusiasm.

Which concludes my overview of languages. I haven't mentioned STOIC and FORTH, because they're really a kind of assembler language using the programmer as a parser; they make programming a bit easier, but you've got to be into assembler work before you can use them, and this is, after all, the User's Column.

Drawing Conclusions

So what's the best language to learn? I don't know. I like C. I also like what I've seen of Pascal, assuming the current crop will really run on microcomputers. And despite my misgivings, I still find myself using BASIC-80/BASCOM, particularly for quick and dirty jobs.

It seems certain—to me at least—that Pascal is going to be around a long time, especially what with all that DOD support for the Ada variant. Now that there seem to be some decent Pascal compilers available for microcomputers, we're going to see a lot of software written in Pascal, and those who want to modify their software will have to be familiar with the language.

But there may not be a real conflict between Pascal and C. Both are vastly different from BASIC; different in conception, in terminology, but more important, in the "philosophy" or style of programming employing them. Learning either will help break the BASIC habit of sloppy program structure; and having done that, you'll have little trouble learning the other, or indeed any other well-structured language.

And that can't hurt users or programmers.

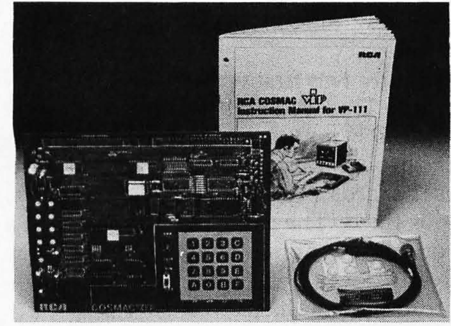
Adventure and Other Games

Now, what about computer games? Well, when microcomputers first came out, games were the rage. It wasn't so much fun to *play* the games, which tended to be rather dull (you wouldn't play much tic-tac-toe with a human opponent); the fun was in writing the programs and seeing just how smart you could make the machine. With the possible exception of *Star Trek*, nobody spent much time with the games once they were written and perfected.

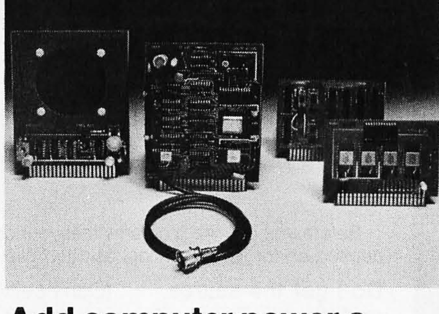
That's no longer true. Nowadays you can buy computer games that are fun to play. For example, at both the West Coast Computer Faire and the National Computer Conference, the most popular exhibit was Atari's. Not that so many were wild about the Atari computers, or the educational games, or that sort of thing, but boy did they stand in line to play *Star Raiders*, a real-time game in which you are a pilot of an X-wing fighter, or perhaps it's a Colonial Viper, and you go zipping about through space destroying villains and saving civilizations....

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microcomputers. *Alien Invader, Space War,* and a whole family of games formerly available only in arcades can be your very own.

There's also an entirely different class of game available. *Adventure* is here.

The game of *Adventure* was first written in FORTRAN by Larry Crowther and Don Woods. It bore some slight resemblance to *Hunt the Wumpus,* in that the game consisted of wandering through unknown territories and encountering various hazards. Unlike *Wumpus,* though, the *Adventure* map is fixed. The game always begins at a well house, and you may continue to explore until you are killed. Actually, it doesn't end even then: the computer will resurrect you if you like.

You move about in *Adventure* by telling the computer where you want to go. The object of the game is to find treasures and bring them to the well house. On the way you encounter various obstacles and monsters, such as a large green snake, a dragon, and a ferocious bear chained to the wall. (The problem is that the bear's silver chain is a treasure.) You also find various objects: a rod, a birdcage, and other such things, some of which may be useful in solving puzzles that lead to treasure.

The game quickly became a cult object among programmers. Computer-installation supervisors estimated that when *Adventure* arrived, two weeks' work would be lost due to the staff bootlegging time to run the game. Various fixes were tried, including restricting the times at which *Adventure* could be accessed, but nothing really worked except letting the disease run its course; when all the programmers had solved the game, then and only then did they get back to work. Until then, they were driven to it as if hypnotized. To make it worse, it was customary not to tell anyone how to solve the game, although strange and misleading hints were allowed.

Adventure now exists for various microcomputers. The game itself is public domain (although programs to implement it are not), so there are many versions offered. I have one for 8-inch floppy-disk CP/M systems sold by Workman and Associates (POB 482, Pasadena CA 91102, $23.95 postpaid) and another for the Radio Shack TRS-80 Level II (Model I) by Microsoft, $24.95, and available from most dealers. Both run quite fast—faster, in fact, than the FORTRAN versions did on a DEC PDP-10. Both require 32 K bytes of memory and a single disk drive, and both are full implementations of the original Crowther and Woods *Adventure,* including the "Save" feature that allows you to store an incomplete game so that you don't have to start over every time.

The Workman version recognizes a number of commands that were not in the original *Adventure,* but the puzzles and their solutions remain unchanged.

In addition, both the Workman and the Microsoft versions store most of the game information on disk, and every time you give a command they have to go to the disk to get the response. There's no help for that, of course; the *Adventure* data base requires over 50 K bytes of ASCII (American Standard Code for Information Interchange) characters. Thus the disk gets a good workout. This presents no problem with the Workman and Associates CP/M version, because any good CP/M copy routine will allow you to make a backup; but the Microsoft TRS-80 *Adventure* has been carefully rigged to make backup copies nearly impossible. I say nearly; within

either TRSDOS or Apparat's NEWDOS it is impossible, but since I have the Omikron CP/M Mapper installed on my TRS-80, I can make backups of anything, using a CP/M sector-by-sector copy routine.

(As an aside: I've been informed that both Parasitic Engineering and Field Engineering Consultants Ltd also make memory mappers that will allow you to run CP/M on the TRS-80 Model I. I've had no chance to test either of them. My Omikron Mapper continues to work flawlessly, by the way.)

I often wonder about companies that deliberately try to keep you from copying software—especially when it's supposed to run on something as inherently flaky as a TRS-80 5-inch disk. Experienced users *never* run their primary source disks; making a backup is just common sense, even if you have excellent hardware like Percom or Matchless disk drives. (I've tested both on my TRS-80, and I'm quite happy with them.) Moreover, making it hard to copy a disk is often like waving a red flag at a bull —there are plenty of sophisticated users who will consider it a challenge, and, having with great effort found a way to make copies, will feel ethically justified in distributing them to all their friends.

In any event, the Workman and Microsoft *Adventure* implementations have provided many hours of trouble-free enjoyment, and I recommend them highly.

Just after the *Adventure* craze hit, there were rumors of another game, *Zork*, which is to *Adventure* as *Adventure* is to *Wumpus*. *Zork* was developed at the Massachusetts Institute of Technology by "the Four Implementors": Tim Anderson, Marc Blank, Bruce Daniels, and David Lebling. The game was written in MDL (or "Muddle"), a LISP-like language, and featured an *enormous* underground dungeon, dozens of clever puzzles, and a highly intelligent command parser that understands much that *Adventure* finds incomprehensible. Although *Zork* never quite caught on the way *Adventure* did, it became widespread—and where it did appear, it cost more time than ever *Adventure* had, because it was both more difficult and more interesting.

Implementors Lebling and Blank have devised a microcomputer implementation of *Zork* in two parts. *Zork: The Great Underground Empire, Part I* is being sold for the Apple II and the TRS-80 on 5-inch floppy disk by Personal Software, 1330 Bordeaux Dr, Sunnyvale CA 94086, at a price of $39.95. [**Editor's note**: *Part II is still under development, but Part I alone constitutes a complete game that can be played through to a satisfactory ending....* **RSS**] Like the Microsoft *Adventure*, *Zork* requires constant access to the disk but cannot be copied by normal means. I've been just a little afraid of running the primary disk, so I haven't checked out everything; besides, the kids are still mapping *Adventure*. I've played with this *Zork* enough to know that I like it (and I wasted incredible amounts of time playing the original *Zork* on a PDP-10).

Adventure and *Zork* became popular during the *D & D* (*Dungeons and Dragons*) craze—a madness which shows little sign of peaking out even yet. It was inevitable that other *D & D* games would come forth, and sure enough, Automated Simulations Inc (ASI), POB 4232, Mountain View CA 94040, has come out with a whole series, from the introductory *Datestones* to the full four-level dungeon in *Temple of Aphsai*. These games are sold in

both tape cassette and disk versions, and they range in price from $14.95 for *Morloc's Tower* on cassette to $26.95 for the disk version of *Temple of Apshai.* ASI guarantees these games to be interesting, and I don't think they refund much money. They've been very popular around here.

There are versions for TRS-80, PET, and Apple computers; the Apple versions make extensive use of Apple's excellent graphics, so that monsters like Ant-man and the Wolf look pretty good. Unfortunately, the TRS-80 doesn't have such nice graphics, and the characters and monsters look like blobs. Unlike *Zork* and *Adventure,* these games are played in real time, and, instead of a room description, the computer draws a map, placing monsters and treasures in it where appropriate. They're very playable games, guaranteed to waste more time than you really expected to put into them.

The *real* time wasters for me, though, have been Automated Simulation's space war games, *Starfleet Orion* (two players) and *Invasion Orion* (one player against the computer). These games allow a number of different scenarios; ten or so are supplied (along with a pleasantly written background and story data including characterizations), but the user can make up his own, so that in effect either of these games has an infinite number of variants. The rulebooks also give a number of standard warship types, but once again the user can design his own, from torpedo boats to dreadnoughts to armored planets. There are Tractor and Pressor beams, something much like a phaser, torpedoes and missiles, and quite a lot of the flavor of a space battle.

I'd like the single-player version somewhat better if it were faster; in my favorite scenario, *Damocles,* it can take several minutes for the computer to plan out its move, and worse, you can't just go away, because the battle results are presented dynamically and can't be recalled once shown.

The *Orion* games are quite realistic. Classical principles of fleet warfare work, and strategy and tactics are more important than luck. Since players can modify the ships at will, it's possible to tailor the games to a balance of power so that an experienced player (or the computer in the single-player version) doesn't routinely stomp a newcomer, and the game can be changed again as the players gain experience.

All of the Automated Simulations games are implemented in BASIC. They can be copied, listed, and even modified. In theory, one ought to be able to compile *Invasion Orion* with Microsoft's TRS-80 version of BASCOM and thus speed it up. Obviously, you will have to modify the games a bit; in particular, you will have to lengthen the loops that govern how long displays stay visible. I'm anxious to try this, but so far the TRS-80 BASCOM hasn't arrived, so I can't say for certain that it will work.

Needless to say, I enjoy all the Automated Simulations games, and recommend them highly. And, needless to say, I enjoy the C language and BASIC-80, etc, etc. So what does it all mean? Well, it means that I have to get the kids away from the TRS-80 and have some computer fun of my own, here at Chaos Manor.

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Books

Kernighan, Brian W and Dennis M Ritchie.
The C Programming Language.
Englewood Cliffs NJ: Prentice-Hall Software Series, Prentice-Hall, 1978, $13.95

Kernighan, Brian W and P J Plauger.
Software Tools.
Reading MA: Addison-Wesley Publishing Company, 1976, $11.95

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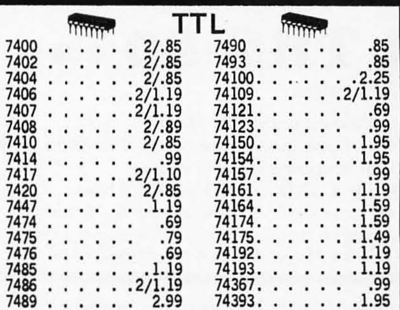
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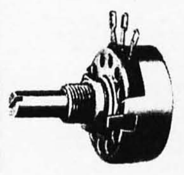


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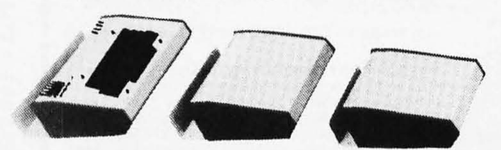
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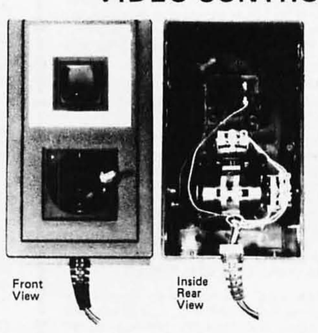
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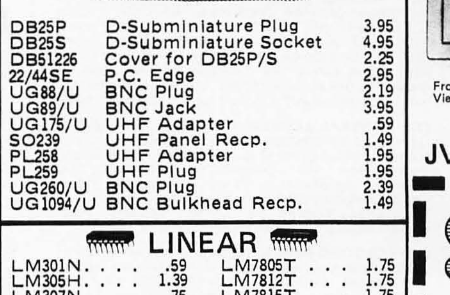
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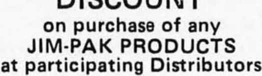
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A Pocket Computer? Sizing up the HP-41C

Bruce D Carbrey
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These days, the introduction of a new pocket calculator is usually greeted with a yawn. This is because calculators have become so commonplace. So what's all the excitement over the Hewlett-Packard HP-41C? The answer is that the HP-41C has novel features that place it a cut above all other calculators and blur the distinction between calculators and personal computers. Hewlett-Packard, not usually given to wild claims, ventures to suggest in the *HP-41C Owner's Handbook and Programming Guide* that the calculator "can even be called a personal computing system." What are the features that separate the HP-41C from the pack?

- twelve-character, true alphanumeric display
- expandable, nonvolatile memory
- plug-in peripherals: magnetic card reader, printer, read-only memory application packs, and a bar-code reader

These, plus a host of convenience features, make this calculator the most versatile machine ever.

The HP-41C has an array of features that blurs the distinction between calculators and personal computers.

Display and Keyboard

Perhaps at some time you have marveled at the ingenuity of the person who discovered that, if you hold your calculator upside down after entering 710.77345, it will read "SHELL OIL". Well, you don't need to resort to tricks like that on the HP-41C, because the usual red seven-segment light-emitting diodes (LEDs) are gone. They are replaced by a large, high-resolution black-on-white liquid-crystal display (LCD) capable of displaying all twenty-six uppercase alphabetic characters, ten numerals, and twenty-three other characters (see photo 1). In addition, the display contains eleven "status annunciators," which inform you of various calculator modes currently active. For example, if you select radian measure instead of degrees for trigonometric functions, "RAD" appears at the bottom of the display. There is even a SHIFT annunciator that indicates when the shift key has been depressed.

The keyboard is HP's usual very high-quality, thirty-five-key, tactile-feedback keyboard, augmented by four push-on-push-off mode-selection switches. With fifty-nine displayable characters and 130 built-in functions, it should be apparent that the thirty-nine keys have several duties. In fact, each key is etched with three labels: its standard (unshifted) function, its shifted function (above the key), and its alpha-mode function (on the bottom sloping side of the key). Alpha-mode characters are enabled as long as the alpha-mode switch is set. The more unusual alpha-mode characters (such as "Σ," "%," "≠," "$," etc) are selected by using the shift key in alpha mode. To keep the keyboard reasonably uncluttered, this set of special characters is not etched on the keys but appears in a pictorial layout on the back of the calculator.

Even with each key potentially performing quadruple duty, there are simply not enough keys for all the functions. To employ one of the more esoteric functions, you depress the execute (XEQ) button and spell the name of the desired function. For example, to compute 12! (12 fac-

torial), you would key in:

1 2 XEQ ALPHA F A C T ALPHA

If you happen to be heavily involved in statistics, you may find this a nuisance because FACT (the factorial function) will be frequently needed. This is where the "programmable keyboard" feature of the HP-41C comes in handy. You can assign or reassign any function to any key you like by using the ASN function. For example:

ASN ALPHA F A C T ALPHA TAN

assigns the FACT function to the button normally used to activate the tangent function. A push-on-push-off USER mode switch determines whether user-defined or standard meanings are currently associated with the keys. If you forget what function you have assigned to a key, you can find out by simply holding down the key. For our example, holding down the TAN button will show "FACT" on the display while in user mode and "TAN" while in normal mode.

User-programmed functions can also be assigned to keys, allowing the calculator to be customized to your application. Two keyboard overlays with stick-on labels are provided for identification of user-defined keys.

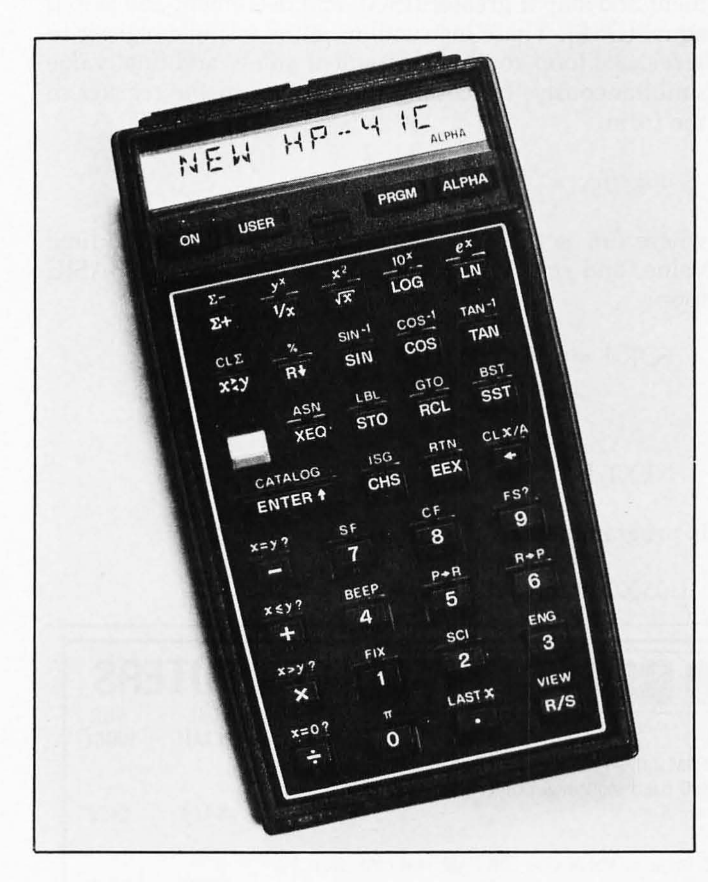


Photo 1: *The Hewlett-Packard HP-41C calculator. Each key on the HP-41C has up to three labels associated with it: the label etched into the top face of the key, the label visible directly above the key, and a letter of the alphabet (enabled by toggling the ALPHA button) etched into the bottom face of the key. Additional functions are called by hitting the XEQ button and spelling out the function name. (Photo courtesy of Hewlett-Packard.)*

To facilitate the entry of multiple-key sequences, the display provides prompting messages, and invalid keys are disabled. In addition to the normal clear-display key, there is a backspace key to facilitate corrections. If you forget the name of a function (programmed or standard), depressing the CAT (catalog) key will list all functions currently known to the calculator.

Memory

The HP-41C has *continuous memory*, which means that the contents of memory are preserved even when the calculator is turned off. You can even replace the batteries without destroying the contents of memory. The HP-41C's size-N throw-away batteries typically last 1 or 2 months, instead of the 9 to 12 months claimed in the documentation. A BAT annunciator warns you when you have only about 2 weeks' worth of life left in the batteries. The HP-41C can also be run using an AC adapter.

Not only are user programs saved in continuous memory, but so is virtually everything relating to the calculator: data, flags, user-key assignments, registers, and display formats. You can even set a flag so that, when you turn on the calculator, it immediately continues executing a program from where it left off when shut down!

The standard calculator contains sixty-three *registers* of memory. Each register is 7 bytes long and can be used to store one number, up to six characters, or several program steps. The total memory space can be partitioned into any combination of program and data storage, or it can be left at the default partition of seventeen data registers and forty-six program registers. The instruction set contains eighty-six 1-byte instructions, thirty-one 2-byte instructions, three 3-byte instructions, and one 4-byte instruction. Instructions with alphanumeric operands such as LABEL, GOTO, etc, use 1 extra byte per character. In a typical mix of instructions, the HP-41C can store about 200 lines of program code in the default forty-six registers of program space. An HP-41C containing four optional expansion-memory modules contains over 2.1 K bytes of continuous memory, capable of storing an average of over 1300 program steps.

Programming

Programming is easier on the HP-41C than on any other calculator. You need not be concerned with addresses or instruction lengths; instead, programs are entered on automatically numbered lines, as is done on many microcomputer text editors. Lines may be freely inserted or deleted anywhere, with automatic renumbering of subsequent lines. Alphabetic labels of up to seven characters can be used for tagging the destination of branches or for program, subroutine, and function names. Also, any number of programs may be resident in memory, each uniquely indentified by an alphabetic name. Programs can be selectively edited, deleted, or entered without affecting other programs.

Best of all, the key codes displayed by other calculators are gone, and are replaced by mnemonic instruction displays. For example, if you examine an instruction for storing a number into register 15 on the Texas Instruments TI-59, it is displayed on three separate lines as "42", "01", "05", where "42" is the TI-59's key code for the STO key. On the HP-41C, however, the same operation is displayed on a single line as "STO 15". This improvement is analogous to stepping up to assembly-language programming from machine-language, an advantage that really speeds up program development and checkout.

Two powerful loop-control instructions have been added to the function repertoire of the HP-41C: increment and skip if greater (ISG), and decrement and skip if equal (DSE). These instructions allow a single register to serve as a loop counter, increment value, and final value simultaneously, by coding the number in the register in the form:

iiiii.fffcc

where *iiiii* is the current counter value, *fff* is the final value, and *cc* is the increment. For example, the BASIC loop:

```
FOR I = 1 TO 50 STEP 2
.
.
.
NEXT I
```

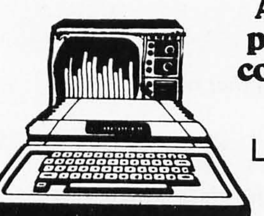
is programmed on the HP-41C as:

1.05002   *iiiii*=1,*fff*=050,*cc*=2

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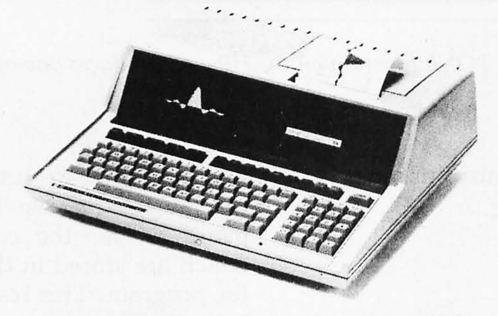
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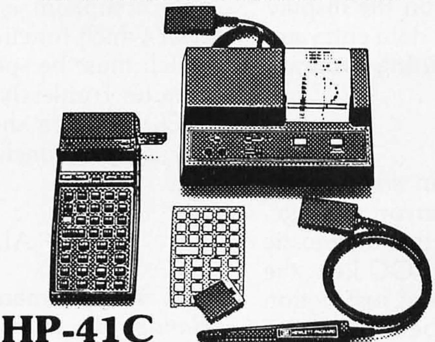
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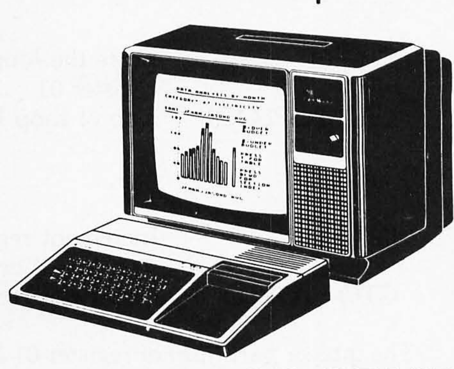
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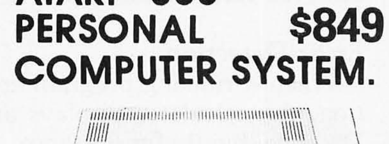
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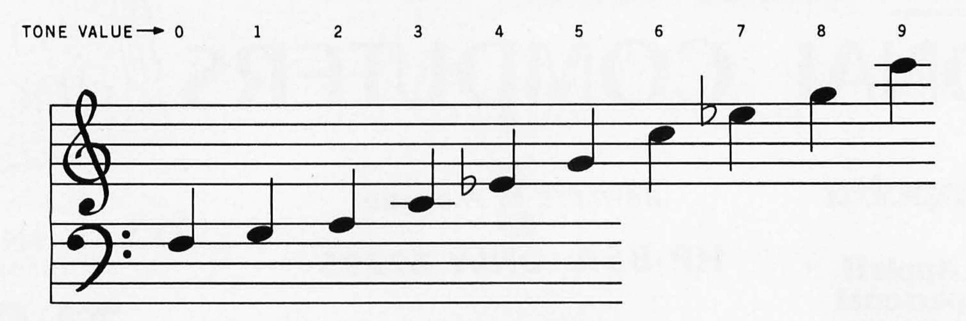


Figure 1: *Musical notes on the HP-41C. The TONE function on the HP-41C produces one of ten musical notes that roughly correspond to the notes presented in this figure.*

STO 01	Store the loop-control number in register 01
LBL "TOPLOOP"	Top of loop label
.	
.	
.	
ISG 01	Increment register 01 by 2, skip next line if greater than 50
GTO "TOPLOOP"	Otherwise, repeat this loop

The integer part (*iiiii*) of register 01 is incremented by 2 in each pass until 51 is reached; the GTO is then skipped and the loop is exited at the bottom.

A full complement of indirect operations (including indirect subroutine calls) and register arithmetic are supported. Subroutines may be nested up to 6 levels deep. Ten different compare operations are available, including a test for character string equality. Fifty-five flags are provided, some of which are predefined for controlling calculator functions such as display format, mode of operation, etc.

There are eleven user-defined flags, five of which have built-in status annunciators on the display. I found the flags with annunciators useful for monitoring program execution during debugging. Since running programs have complete control over the display format, it is easy to display several labeled numeric values on the display at the same time. User-defined prompts for data entry are also easily programmed. In fact, an executing program can even turn the calculator off.

Error Detection

When a running program encounters an error condition, the calculator displays an English error message. Dividing by 0, for instance, produces the diagnostic "OUT OF RANGE". If you depress the PROG key, the display will show the exact line number and instruction that caused the error. If desired, a flag can be set to ignore errors, or errors can be detected under program control for user-specified recovery.

Besides flags for various error conditions, there are flags that detect whether the data entered is numeric or alphabetic in nature. Since these flags are set only if data is entered, they can be used in conjunction with the PAUSE function to poll the keyboard during program execution to see if a key has been depressed. The PAUSE instruction activates the keyboard for about 1 second, after which normal execution resumes. The data entry flags can be tested to see if any keys were depressed during a pause; if so, the corresponding key indentifications, which are stored in the display register, are available to the program. This feature facilitates the programming of games with real-time user responses.

Let the Music Play

The calculator can produce ten different audible tones under keyboard or program control. I found the volume level of the tones a little too low for my taste; it is barely audible in a noisy office. After successfully programming "Mary Had a Little Lamb," I decided to tabulate which musical notes are actually provided; the results are presented in figure 1. Those with perfect pitch may find the error in the frequencies of the notes a little annoying, but the tones are close enough to produce recognizable music.

Documentation

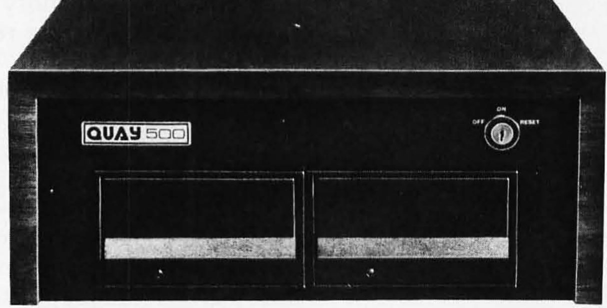
One of life's little pleasures is reading Hewlett-Packard documentation, which is among the best in the industry. It took me three evenings to finish the entire 268-page *HP-41C Owner's Handbook*, working each example program as I read. For me, the manual struck just the right balance between simplicity and comprehensiveness. My only complaint is that the text does not always make clear which functions are available on the keyboard and which must be spelled out. For instance, I spent several minutes fruitlessly searching for the multiple-line-delete (DEL) function shown in the example on page 138 as a key, only to conclude that it must be accessed by depressing:

XEQ ALPHA D E L ALPHA

A second manual, *HP-41C Standard Applications Handbook*, gives ten sample programs ranging from hexadecimal conversions to a blackjack game. These programs detail a wealth of programming techniques including random-number generation, character-string concatenation and substring extraction, display formatting, table lookup, etc. In addition, a year's free membership to *Keynotes*, the HP calculator newsletter, is included with your purchase.

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Photo 2: *The HP-41C and accessories. Clockwise from top are: the 82143A peripheral printer, a key overlay (for use when redefining key functions), the HP-41C with the 82104A plug-in card reader, two magnetic cards, and three read-only-memory application packs. In the center is the 82153A bar-code wand, which is used to read software printed in the form of bar codes. (Photo courtesy of Hewlett-Packard.)*

titles you to a catalog of contributed programs, updates to the catalog, and a coupon good for four free programs of your choice, distributed on magnetic cards. Additional programs are $6 each. You may submit programs to the library in return for four free programs from the library.

Expansion

One of the most exciting aspects of the HP-41C is the array of available peripheral devices, including:

- a twenty-four-column thermal printer
- an attachable magnetic card reader/writer
- application packs in read-only memory
- continuous-memory expansion modules
- bar-code program reader

Several of these accessories are shown in photo 2.

The 82143A battery-powered thermal printer produces 127 characters, including all uppercase and lowercase letters, in either single width (twenty-four characters per line) or double width (twelve characters per line). (See photo 3 for an example of printer output.) In addition, user-defined characters may be defined within a 7 by 7 dot matrix. Simple printer-plots are supported. The printer can also be used to trace program execution during debugging.

The 82104A magnetic card reader is similar to the built-in unit on the HP-67 and HP-97 and is compatible with cards produced on these machines. Up to sixteen registers can be stored on each side of a card; the calculator prompts you to enter as many cards as needed. Programs, data flags, and even key reassignments can also be saved on the cards. For the security-minded, programs can be designated as *execute-only*, in which case an attempt to display or alter the program will result in the display of the message, "PRIVATE."

Plug-in application packs (useful routines stored in read-only memory modules) are available in disciplines such as aviation, medicine, surveying, finance, stress analysis, etc. Programs in these applications modules can be copied into continuous memory, if desired, for customizing by the user.

For large programs, from one to four 82106A continuous memory modules may be plugged in to extend the built-in memory from the standard 63 to a maximum of 319 registers, in 64-register increments. The extended memory can be partitioned between program and data storage and is continuous, just like the memory supplied with the standard HP-41C.

An accessory just recently made available is a wand that is used to read bar-codes similar to the kind found on most grocery products. This will enable users to load programs directly from HP-41C Solution Books to be published by Hewlett-Packard, which will use bar-code listings of programs to supplement the usual step-by-step keystroke listings. An HP-41C user with a bar-code wand will be able to enter these programs by running the wand across the bar-code listing, eliminating the tedium and error associated with manually entering a program.

The Great Calculator Race

A strong contender for the programmable calculator market is the Texas Instruments TI-59, which sells for less money than the Hewlett-Packard machine and includes a

standard magnetic card reader and larger standard memory (960 bytes, as opposed to 441 bytes on a standard HP-41C). (Price information for the Hewlett-Packard machine is given at the end of this article.) Of course, it doesn't have an alphanumeric display or continuous memory; still, it is an attractive alternative to the HP-41C.

I decided to run a small benchmark test to compare speed and memory usage on both machines. Conducting proper benchmark tests is an involved and time-consuming process. Instead, I settled for one representative test that should be adequate for at least rough comparison. I programmed both the HP-41C and the TI-59 to compute the present value of a bond with "periodic coupons," as given by the formula:

$$P = I\sum_{J=1}^{N}(1+Y)^{-J} + M(1+Y)^{-N}$$

where:

P = present value
I = coupon value
N = number of periods
M = maturity value
Y = yield rate, in percent

I picked this example because it requires a mix of arithmetic, looping, and register operations; I intuitively felt that this mixture is representative of the operations performed in many of the problems suitable for pocket calculators. I programmed both calculators in the same manner, deliberately trying to avoid "trick" programming but taking advantage of each machine's strengths where possible (such as short-form addressing on the TI-59 and stack manipulation on the HP-41C).

The programs for the HP-41C and the TI-59 are in listings 1 and 2, respectively. Although I expected the HP-41C to run slower since it uses ultra-low-power technology, both calculators took about the same amount of time to execute the benchmark. The HP-41C program uses less memory space, but of course it has only about half as much memory available in its standard configuration.

Listing 1: *HP-41C benchmark program to calculate the present value of a bond with "periodic coupons." This problem, described in the text, was used as a benchmark program against the Texas Instruments TI-59 because it uses both arithmetic calculations and program looping. The TI-59 benchmark program is given in listing 2, and the results of the comparison are given in table 1.*

HP-41C program steps often consist of multiple keystrokes; each step is shown in this listing as it appears in the calculator's display after entry, with one exception: characters entered in alphabetic mode on the calculator are shown here enclosed in quotes. On the calculator's display the quotes do not appear, but the characters are preceded by a superscript "T".

REGISTERS

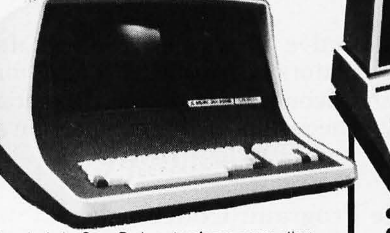
R_1 M, maturity value
R_2 N, number of periods and J, loop index
R_3 I, coupon value
R_4 1 + Y, where Y is yield rate as decimal fraction

LINE	PROGRAM STEP	COMMENTS
01	LBL "BOND"	
02	FIX 2	Set dollars and cents format
03	STO 01	SAVE M in 01
04	STOP	Input N
05	STO 02	Save N in reg 02
06	STOP	Input I
07	STO 03	Save I in reg 03
08	STOP	Input Y
09	100	
10	/	Convert to decimal fraction
11	1	
12	+	
13	STO 04	Save (1 + Y) in reg 04
14	RCL 02	
15	CHS	
16	Y⁄X	$(1 + Y)^{-N}$
17	RCL 01	
18	*	$M*(1 + Y)^{-N}$
19	0	Initialize sum to 0
20	LBL 01	Top of summation loop
21	RCL 04	(1 + Y)
22	RCL 02	J
23	CHS	− J
24	Y⁄X	$(1 + Y)^{-J}$
25	+	New summation
26	DSE 02	J = J − 1...
27	GTO 01	...Until J = 0
28	RCL 03	Then recall I
29	*	Times summation
30	+	Plus second term = result, P
31	END	

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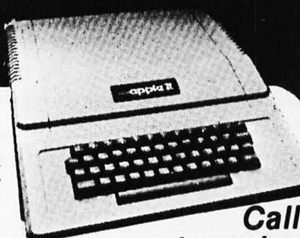
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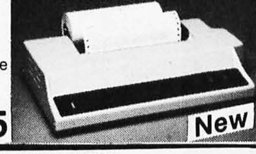
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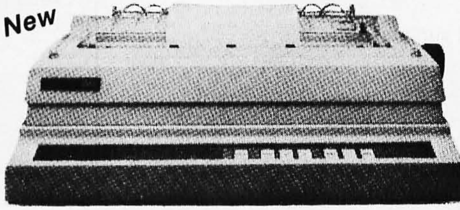
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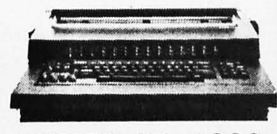
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Listing 2: *Texas Instruments TI-59 benchmark program to calculate the present value of a bond with "periodic coupons." The results of the comparison with the HP-41C are given in table 1.*

REGISTERS

R_1 M, maturity value
R_2 N, number of periods, and J, loop index
R_3 I, coupon value
R_4 1 + Y, where Y is yield rate as decimal fraction
R_5 scratch register for summation

DISPLAY LINE	DISPLAY CODE	KEY ENTRY	COMMENTS
000	76	LBL	
001	11	A	
002	58	FIX	Set dollars and cents format
003	02	2	
004	42	STO	
005	01	1	Save M in reg 01
006	91	R/S	Input N
007	42	STO	
008	02	2	Save N in reg 02
009	91	R/S	Input I
010	42	STO	
011	03	3	Save I in reg 03
012	91	R/S	Input Y
013	55	/	
014	01	1	Convert to decimal fraction
015	00	0	
016	00	0	
017	85	+	
018	01	1	
019	95	=	
020	42	STO	
021	04	4	Save (1 + Y) in reg 04
022	45	Y^x	$(1 + Y)^{-N}$...
023	43	RCL	
024	02	2	
025	94	+/−	
026	65	×	
027	43	RCL	
028	01	1	
029	95	=	
030	42	STO	
031	05	5	Save $M^*(1 + Y)^{-N}$
032	25	CLR	
033	42	STO	
034	06	6	
035	76	LBL	
036	44	SUM	Top of summation loop
037	43	RCL	
038	04	4	
039	45	Y^x	
040	43	RCL	
041	02	2	
042	94	+/−	−J
043	95	=	$(1 + Y)^{-J}$
044	44	SUM	New summation
045	06	6	
046	97	DSZ	J = J − 1...
047	02	2	
048	44	SUM	...Until J = 0
049	43	RCL	
050	03	3	Then recall I
051	49	PRD	
052	06	6	Times summation
053	43	RCL	
054	05	5	2nd term
055	85	+	
056	43	RCL	
057	06	6	Plus first term...
058	95	=	Result is P
059	91	R/S	
060	00		

A subjective conclusion I drew after programming both calculators is that the HP-41C is *much* easier to program and debug because of its line-oriented, mnemonic display. The results of this comparison are given in table 1.

Sample Program: Codebreaker

Because I am a games enthusiast, I decided to write a game program as an example of an HP-41C program. I programmed a variation of the popular "codebreaker" type games, where the calculator generates a random code and the player attempts to guess the code. The flowchart for this program is given in figure 2.

To begin, the player first decides on the number of digits for the code, from three to five digits. Assume that a three-digit game is chosen. The calculator will then secretly pick a three-digit number *with no two digits the same*. The user then enters a three-digit guess.

After evaluating the guess, the calculator displays the number of digits that are exactly right and the number of digits that exist in the true code but are not in the proper position. For example, if the secret code is 108 and 802 is the guess, the display will show:

802 RT:1 MP:1

indicating one entirely right (RT) digit (the 0) and one misplaced (MP) digit (the 8).

The user continues guessing until the correct answer is

Text continued on page 258

	TI-59	HP-41C
Number of data registers used	5	4
Program size (as displayed)	59 lines	31 lines
Program size (internal representation)	59 steps	41 bytes
Total memory used/total memory	99/960	69/441 (69/2233)
Percentage of total memory used	10.3	15.6 (3.0)
Execution time, seconds	43	37

Benchmark equation programmed:

$$P = I \sum_{J=1}^{N} (1 + Y)^{-J} + M(1 + Y)^{-N}$$

Data used:

$M = 20{,}000,\ N = 50,\ I = 1400,\ Y = 8\%$

Answer: $P = 17{,}533.30$

Table 1: *Results of the HP-41C/TI-59 benchmark. The programs of listings 1 and 2 are the basis of the data given above. The difference between the two program-size figures for the HP-41C is due to the fact that it combines several program steps into an assembly-language-like instruction when displaying it. The figures in parentheses refer to the HP-41C filled with its maximum amount of memory; the figures just before them refer to the HP-41C as purchased.*

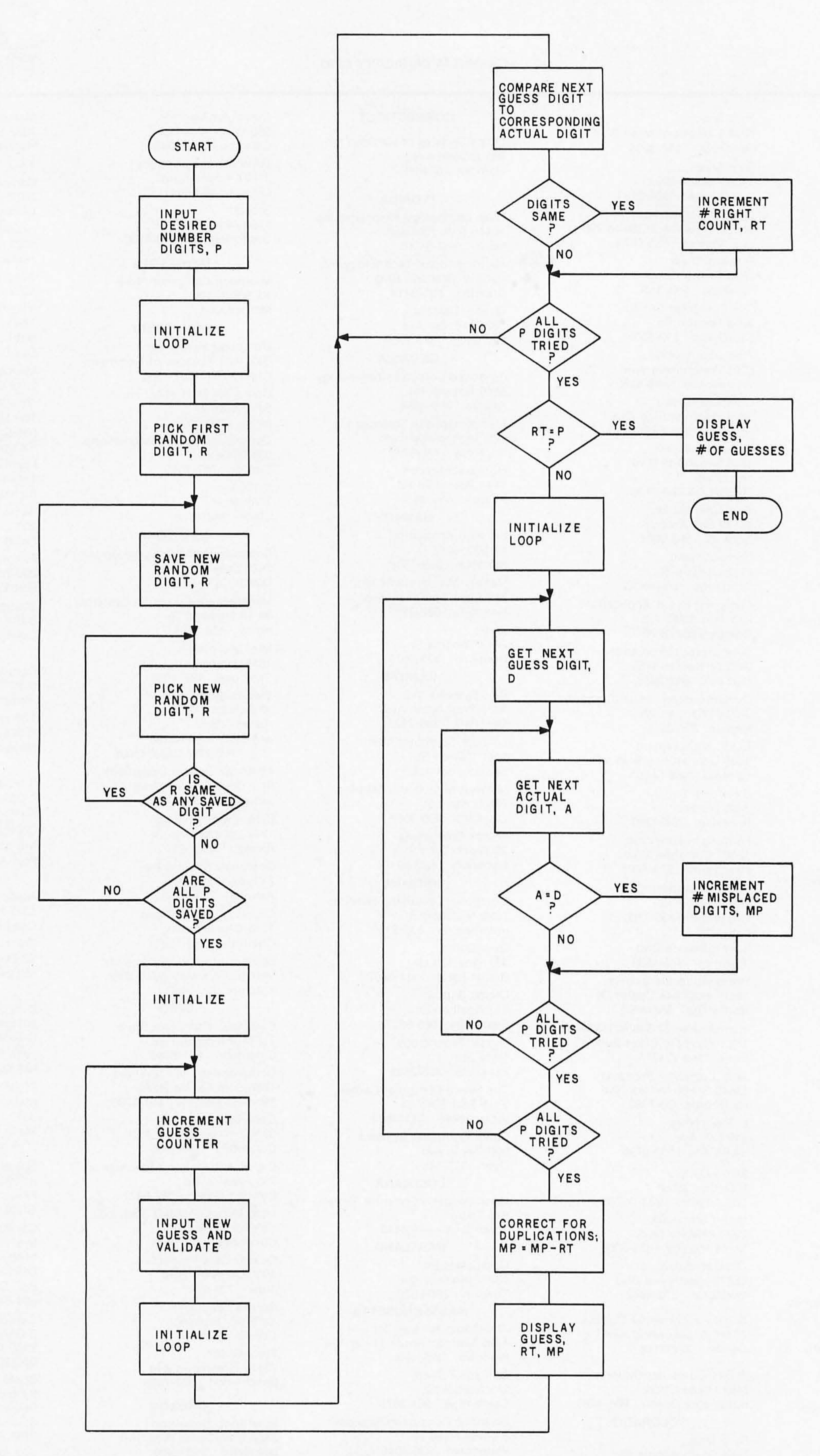
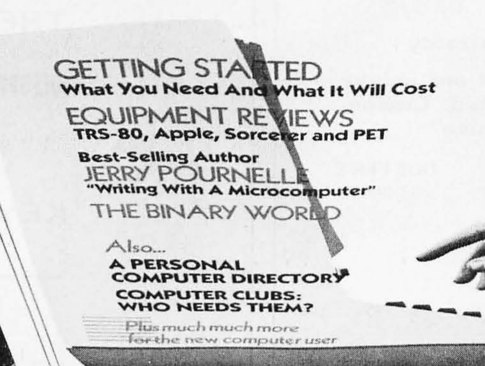


Figure 2: *Flowchart for the HP-41C Codebreaker game. Listing 3 gives the HP-41C keystrokes for the equivalent program.*

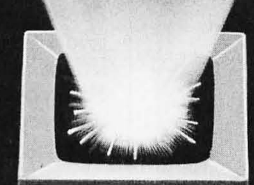
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Photo 3: *Sample thermal printer output. The 82143A peripheral printer is capable of printing both uppercase and lowercase letters, as well as numbers, symbols, and user-defined special characters, all in two print densities. The printer can also be used for program tracing or equation plotting. (Print sample courtesy of Hewlett-Packard.)*

Text continued from page 254:

obtained; the number of guesses made is then displayed and the game is over. Since the game displays results from only the most recent guess, pencil and paper are good accessories for keeping track of previous guesses and results.

Examining the Program

Several interesting capabilities of the HP-41C are explored in this program (see listing 3). Line 02 places a text string into the alphanumeric display register, which holds from zero to twenty-four characters. Line 03 causes the register's prompting message to be displayed and halts for user input. Lines 04 thru 11 validate the user input and save the desired number of digits, *P*, in register 00.

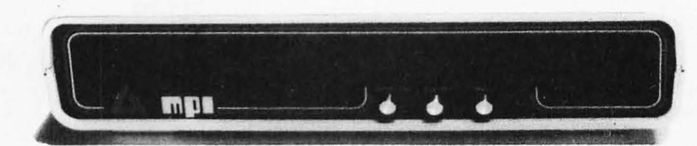
Lines 12 and 13 initialize the display format as integer only with no decimal point displayed. Lines 14 thru 16 tell the player how many random digits will be picked. Line 17 is a call to subroutine RDIG, which returns a random digit, 0 to 9; I used the random-number generator described in the *HP-41C Standard Applications Handbook*.

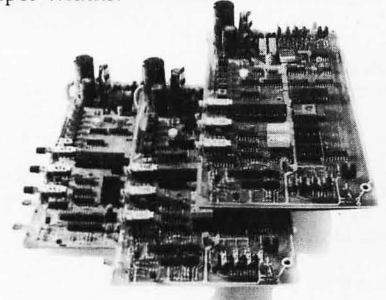
Text continued on page 262

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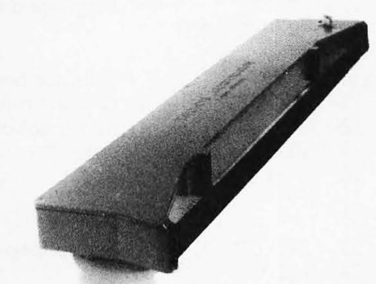
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Listing 3: *HP-41C Codebreaker game program. This program chooses a random 3- to 5-digit number with nonrepeating digits and gives the player clues about the code, based on the player's guesses. This listing uses the same conventions as listing 1.*

REGISTERS

R_0 Number of digits (positions) to play, P, $3 \leq P \leq 5$
R_1 First digit of actual code number
R_2 Second digit of actual code number
R_3 Third digit of actual code number
R_4 Optional fourth digit of actual code number
R_5 Optional fifth digit of actual code number
R_6 Current user guess, normalized to 0.ddddd format
R_7 Scratch for loop control
R_8 Scratch for indirect register access, loop control
R_9 Number of exactly right (RT) digits in current user guess
R_{10} Number of misplaced (MP) digits in current user guess
R_{11} Seed for random number generator
R_{12} Count of number of guesses made by user

LINE	PROGRAM STEP	COMMENTS
01	LBL "MM"	Program name
02	"NO. DIGITS?"	
03	PROMPT	Prompt user to enter no. of digits, 3 to 5
04	STO 00	Save P places requested
05	3	
06	X>Y?	
07	GTO "MM"	If less than 3 places, re-prompt
08	RDN	
09	5	
10	X<Y?	
11	GTO "MM"	If P greater than 5, re-prompt
12	FIX 0	Show no fractional part in display
13	CF 29	Suppress display of decimal point
14	"IM PICKING "	
15	ARCL 00	
16	AVIEW	Tell user how many random digits
17	XEQ "RDIG"	Get first random digit, 0 to 9
18	RCL 00	Recall no. of places, P, 3 to 5
19	1000	
20	/	
21	1	
22	+	
23	STO 07	Set up loop control in form 1.00P
24	LBL 01	
25	RDN	
26	STO IND 07	Store new digit in array
27	LBL 02	
28	XEQ "RDIG"	Get candidate random digit, 0 to 9
29	RCL 07	
30	INT	
31	STO 08	Last position filled
32	LBL 03	
33	RDN	Recall candidate
34	RCL IND 08	Recall existing digit
35	X=Y?	If candidate is same as existing digit...
36	GTO 02	...then go get a different random digit
37	DSE 08	Else check next existing digit...
38	GTO 03	...until all existing digits checked
39	ISG 07	Then fill next position with candidate...
40	GTO 01	...until all P positions filled
41	0	
42	STO 12	Initialize count of guesses made
43	"GUESS?"	
44	LBL 04	
45	PROMPT	Get P-digit user guess
46	10	
47	RCL 00	
48	Y↑X	10^P
49	X<=Y?	If guess greater than P digits...
50	GTO 04	...then go get legal guess
51	/	Else normalize valid guess
52	STO 06	Save guess in format 0.ddddd
53	0	
54	STO 09	Initialize count of "right" digits
55	STO 10	Initialize count of "misplaced" digits
56	1	
57	ST+ 12	Increment guess counter
58	RCL 00	
59	STO 07	P
60	LBL 05	
61	RCL IND 07	Actual code digit
62	XEQ "GDIG"	Get digit from user's guess
63	X≠Y?	Compare corresponding actual digit
64	GTO 06	
65	1	
66	ST+ 09	If match, increment right count
67	LBL 06	
68	DSE 07	Repeat for all P digits
69	GTO 05	
70	RCL 09	
71	RCL 00	
72	X=Y?	If number right = P...
73	GTO 14	...exit, game over
74	STO 07	Else set up for "misplaced" counting
75	LBL 07	
76	RCL 00	P
77	STO 08	Set up inner loop count
78	XEQ "GDIG"	Get digit from user guess
79	ENTER↑	
80	LBL 08	
81	RDN	Recall guess digit
82	RCL IND 08	Digit from actual number
83	X≠Y?	
84	GTO 09	
85	1	
86	ST+ 10	If same, increment "misplaced" count
87	LBL 09	
88	DSE 08	Repeat for P positions, inner loop
89	GTO 08	
90	DSE 07	Repeat for P positions, outer loop
91	GTO 07	
92	RCL 09	
93	ST− 10	Correct "misplaced" count is (MP − RT)
94	XEQ "SHOG"	Show guess in display
95	"⊢ RT:"	
96	ARCL 09	Show no. of digits exactly right, RT
97	"⊢ MP:"	
98	ARCL 10	Also show number "misplaced," MP
99	GTO 04	Go get new guess
100	LBL 14	Come here on end-of-game only
101	XEQ "SHOG"	Show correct guess
102	"⊢ "	
103	ARCL 12	Show count of guesses used
104	"⊢ TRIES"	
105	AVIEW	
106	BEEP	Ring the bell to celebrate
107	RTN	End program.
108	LBL "SHOG"	Subroutine to display guess
109	RCL 00	Recall P
110	STO 08	Number of digits to display
111	CLA	
112	RCL 06	Recall normalized guess, 0.ddddd
113	LBL 12	
114	10	
115	*	Shift out next digit
116	ENTER↑	Save on stack
117	INT	Discard fraction
118	10	
119	MOD	Get units place only, 0 to 9
120	ARCL X	Display digit

Listing 3 continued on page 262

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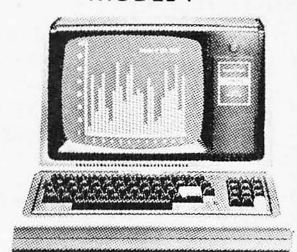


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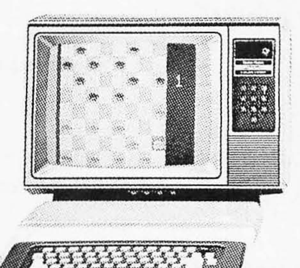
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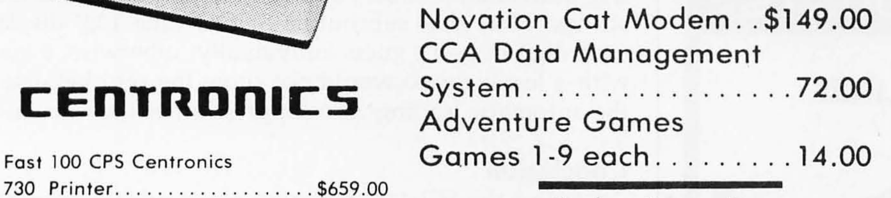


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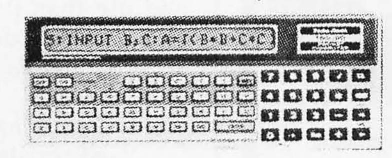
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Listing 3 continued:

```
121  RDN           Recall shifted guess
122  DSE 08        Repeat till all P digits displayed
123  GTO 12
124  RTN           Return from subroutine
125  LBL "GDIG"    Subroutine to return 1 digit of guess
126  RCL 06
127  10
128  RCL 07        Register 07 = desired position in guess
129  Y↗X
130  *
131  INT
132  10
133  MOD
134  RTN           Return from subroutine
135  LBL "RDIG"    Come here to get random digit, 0 to 9
136  RCL 11        Seed
137  9821
138  *
139  .211327
140  +
141  FRC           New random seed, 0 to 1
142  STO 11
143  10
144  *
145  INT
146  RTN           Return from subroutine, digit on top of stack
147  END
```

Text continued from page 258:

The most interesting part of the program is contained in lines 18 thru 40, which consist of two nested loops for selecting *P* random digits with no two digits the same. Lines 18 thru 23 initialize the outer loop control parameters in register 07. For example, if three digits are desired, register 07 will be initialized to 1.003. The end of the loop is on lines 39 and 40, with line 39 incrementing register 07 until it reaches 3.

Register 07 is used inside the loop as the subscript for an array of size *P* in registers 01 thru *P*, each to contain one digit of the code number. An inner loop, controlled by register 08, compares all previously selected digits to the new candidate digit, and rejects any duplications. The logic of this code selection segment of the program can be illustrated by its BASIC equivalent:

```
10 DEF FNR = INT(RND*10)
.
.
.
100 D = FNR
110 FOR I = 1 TO P
120     N(I) = D
130     D = FNR
140     FOR J = 1 TO I
150         IF N(J) = D THEN 130
160     NEXT J
170 NEXT I
```

After the code is selected, the user's guess is entered. Each user guess is stored in register 06 in a normalized format obtained by dividing the guess by 10^P. For example, a guess of 012 would be stored as .012 in a three-digit game; a guess of 30987 would be stored as .30987 in a five-digit game. This format is used so that function GDIG (line 125) can extract the *I*th digit, *D*, from the guess, *G*, by calculating $D = MOD_{10}\ (INT\ (G \times 10^I))$.

The balance of the program is fairly straightforward. Lines 94 thru 98 illustrate how to simultaneously display five individual numbers and two alphanumeric character strings. Note that subroutine SHOG (line 108) displays each digit of user's guess individually; otherwise, a guess with a leading zero would not show the zero because of the automatic leading-zero suppression of the calculator.

Conclusion

I found the HP-41C far more pleasurable to program and use than its predecessors, primarily because of the alphanumeric display capabilities. The list prices of the HP-41C and its accessories are as follows:

HP-41C programmable calculator (with 63-register memory)	$295
82106A 64-register Memory Module	45
Application Pacs, each	45 to 70
82143A Peripheral Printer	350
82104A Plug-in Card Reader	195
82153A Wand	125
HP-41C Solution Books	12.50
82045A Thermal Paper (box of six rolls)	6
82120A Rechargeable Battery Pack	40

I am able to find discounts of about 15% off the list price in my area. Larger discounts can be expected with the passage of time. The HP-41C is manufactured by Hewlett-Packard Co, Corvallis Division, 1000 NE Circle Blvd, Corvallis OR 97330.

Is the HP-41C a pocket computer? Well, maybe not quite—but what will the *next* generation of calculators be like?■

Microsoft Adventure

Bob Liddil, POB 66, Peterborough NH 03458

For there are treasures to be found
As mysteries unfold
In the depths of the great unknown
In the search for yellow gold.
But beware the shadows,
For who knows what they hold
In the great Colossal Cave?
From "Adventure's Song"
—Freerover the Bard

Of all the computer simulations available for the microcomputer user, none stirs the imagination quite like Adventure. And of all the Adventure games Microsoft's is one of the most intriguing.

The premise of this *Adventure*, exploration of the Colossal Cave, is not a new one. It is, in fact, the basis for the original *Adventure* that has been appearing around university campuses and mainframe computers for years. According to Microsoft, the Digital Equipment Corporation PDP-10 version is reproduced faithfully for the TRS-80 with 32 K bytes of programmable memory and a single disk drive.

[**Editor's note:** *I had the good fortune to log onto a Digital Equipment Corporation PDP-11/70 that was running the original* Adventure. *This version credited Willie Crowther with the original version of the program and Don Woods with "most of the features of the current version." Although the Softwin Company is credited with writing the Microsoft* Adventure, *the names of Willie Crowther and Don Woods should be added to the list. Short sessions with both the Microsoft and the PDP-11 versions of the* Adventure *showed them to be virtually identical in content, program logic, and wording. Mr Letwin has added some features (described below) and has made slight format changes that make the version more playable....* **GW**]

The Microsoft *Adventure* sets itself against the *de facto* norm later established by Scott Adams. The split screen, the blinking cursor, all the slick niceties of the Adams and similar Adventures are missing. That does not detract from the game, though, because they are replaced by technical innovations that make game play easy and painless.

The *Adventure's* acceptance of shorthand commands is a joy. Instead of tediously typing GO HOUSE or GET KNIFE, one needs only type HOUSE or KNIFE. The computer understands and complies. The directional shorthand commands, N, S, E, W, U, and D (for the four compass points and the directions UP and DOWN), are convenient. Adventurers will be very comfortable with the ease with which this program functions.

Adventurers in the Colossal Cave will come across situations they may recognize from other Adventures. This is acceptable. It gives a player a sense of comfort and familiarity in an otherwise hostile environment.

Most of the descriptions used for locations and objects are stored on the floppy disk and called only when needed. This arrangement prevents the descriptions from being terse as a result of limited program space. These plush and vivid descriptions add much to the enjoyment of the game. The puzzle of this *Adventure*, while difficult to

At a Glance

Name
Microsoft *Adventure*

Type
Adventure game

Manufacturer
Microsoft Consumer Products
10800 NE Eighth, Suite 819
Bellevue WA 98004
(206) 454-1315

Price
$29.95

Format
5-inch floppy disk

Language
Machine language

Computer
Radio Shack TRS-80 Model I with single disk drive and 32 K bytes of memory (also available for Apple II with one disk drive and 32 K bytes of memory; same price)

Documentation
Instructions in game, plus short booklet

Audience
General audience



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decipher fully in one or even a half dozen sittings, is not impossible. It is well laid out, challenging, and presented logically. It is solvable, given time.

There are monsters lurking in the shadows. There is, in the first level of the cave, a knife-wielding dwarf who attacks repeatedly at nearly every turn. I suspected for a while that there was a dwarf-cloning machine somewhere far below me in the depths of the cave, turning out rubber-stamp dwarves that stood in line to try to kill me. As fast as I dispatched one, another popped up to take his place.

Just out of plain view, a mystery figure beckons to me in the dim light. In trying to reach this spectre, to find out why he/she/it is there, I got lost in a maze of crisscross tunnels, not once but five times.

The nonplayer characters are not the only barrier to your progress as an adventurer. The cave is the adventurer's worst enemy. Its passages twist and turn, creating the kind of terminal (*sic*) frustration that has made this *Adventure* a favorite of thousands of personal-computer users.

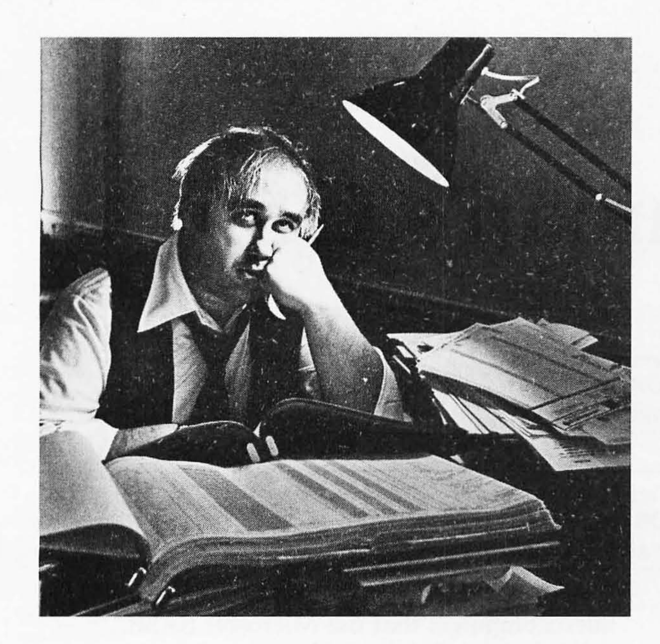
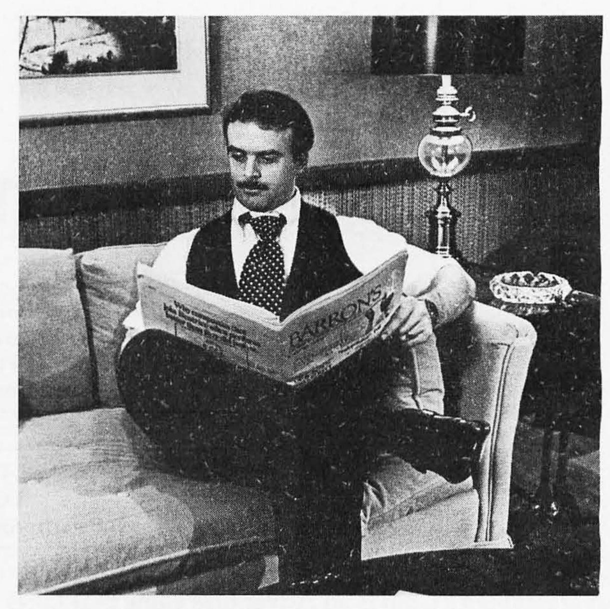
The game is divided into three skill levels consisting of the beginning, intermediate, and advanced caves. The intensity of play increases by level so that, by the time the *Adventure* program offers a Grandmaster game to a player, the player has survived virtually every fantasy situation conceivable. The Grandmaster level is attainable only after every other puzzle is solved and all treasures have been obtained. Few Grandmasters exist. It is a goal worth working toward.

The Microsoft *Adventure* is a gold mine for the enthusiast and a nightmare for the software pirate. (After all, you would expect Microsoft to actively protect its product.) I was unable to copy the Microsoft *Adventure* disk, even with the help of several disk inspection/modification programs.

The Microsoft *Adventure* is attractively packaged and well documented. The buyer should have no trouble finding it on the pegboard of his local computer store. It is well worth the price being charged. The Adventure lover is in for many hours of pure enjoyment with this one.

Conclusions

- This is an interesting Adventure in many ways. First, it is the original *Adventure* that was first running on a PDP-10. It is also one of the most sophisticated Adventure games I have seen. Since it is written in machine language, it is faster than the Adventures that are written in BASIC. It draws its descriptions from the floppy disk; therefore it is a fuller Adventure than most other Adventures, which offer limited description as a result of storing the text with the program and are limited by the amount of memory in the computer.
- This *Adventure* has a different format from that of other microcomputer Adventures. This should not be construed as a shortcoming; I mention it only for the benefit of Adventure enthusiasts accustomed to the other, more recent format.
- Microsoft *Adventure* is actually a series of Adventures that reveal themselves as the player becomes more skillful. It can be enjoyed by both the novice and the experienced player. The ability to save the game on disk allows a player to take advantage of deeper levels of play without being confined to one sitting. ■

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Lost Dutchman's Gold

Bob Liddil
The Programmer's Guild
POB 66
Peterborough NH 03458

Teri Li
POB 481
Peterborough NH 03458

Lost Dutchman's Gold is an Adventure game that takes place in the Old West at the turn of the century. The object of the game is to find the gold (and other treasures) hidden in the Lost Dutchman's Mine and successfully find your way out. The Adventure starts in an abandoned miner's shack where you'll find a rifle and a shovel. If you can find it, there is also a map of the mine hidden somewhere to help you on your Adventure.

This program (see listing 1) is written in Applesoft BASIC and requires 24 K bytes of memory and one disk drive. It will also run on nondisk Apples if the commands related to saving a game to disk are deleted. With some modifications, this Adventure game should run on other microcomputers that use Microsoft BASIC.

[*Unfortunately, the disk commands in this program contain invisible control-D characters at the beginning of some lines. (It is the control-D character that signals the beginning of a disk command within a PRINT statement.) All PRINT statements that begin with the words OPEN, CLOSE, READ, WRITE, VERIFY, and NOMON should have as their first character the invisible control-D character. To the best of my knowledge, the lines that need this character are lines 36, 85, 95, 2535, 2550, 4000, and 4100. We regret this inconvenience to our readers....*GW] ■

Listing 1: Lost Dutchman's Gold. *Written in Applesoft BASIC, it requires 16 K bytes of programmable memory.*

```
10   POKE 34,0: POKE 35,24: TEXT :
      HOME
20   VTAB 5: PRINT "  WELCOME TO T
      HE SEARCH FOR THE LOST    DU
      TCHMAN'S GOLD.  I'M THE GHOS
      T OF BACK-PACK SAM, YER GUID
      E ON THIS ADVENTURE.
                            YA CAN
      USE 2 WORD COMMANDS TO FIND
      CLUES'N MOVE 'BOUT.  GET, G
     O, PUT, DROP,
30   PRINT "SCORE, INVENTORY 'N 'B
      OUT 100 MORE WORDSMAKE SENSE
       TA ME.  ASK FER HELP IF YA
        GET STUMPED.": PRINT "
                                I HO
     PE YA DON'T END UP A GHOST,
     LIKE ME!

             GOOD LUCK!!
35   REM WORLD COPYRIGHT (C) 1980
      BY TERI LI. ALL RIGHTS
      RESERVED.
36   DIM N$(26,7),O$(32,3),R$(46):
      B = 0:IN = B:LN = 50:LM = LN
      :X1 = B:X2 = B:T$ = "":M1$ =
      T$:M2$ = T$:QM$ = T$:U = B:U
      1 = B:IM = 2:BD = 21:L = 1:C
      $ =  CHR$ (13): PRINT "NOMON
      I,O,C
40   FOR L = B TO 26: FOR I = B TO
      7: READ N$(L,I): NEXT I,L
50   FOR I = B TO 32: READ O$(I,0)
      ,O$(I,1),O$(I,2):O$(I,3) = "
      ": NEXT
60   FOR I = B TO 46: READ R$(I): NEXT

70   PRINT "
             HIT 'SPACE' TO START."
      : GET QM$:L = 1: INPUT "REST
      ORE OLD GAME?";QM$: IF  LEFT$
      (QM$ + " ",1) < > "Y" THEN
      100
80   INPUT "NAME?";QM$:QM$ = "LDG/
      " + QM$: ONERR  GOTO 4000
85   PRINT "VERIFY "QM$: PRINT "OP
      EN "QM$: PRINT "READ "QM$
90   INPUT L,CL,LN,IN,LM,U,U1,IM
91   FOR X = 0 TO 32: INPUT O$(X,1
      ),O$(X,2),O$(X,3): NEXT
95   PRINT "CLOSE"QM$: POKE 216,0
100   IF ((O$(12,2) =  STR$ (L) OR
      O$(12,3) = "1") AND CL > 0) OR
      L < 15 THEN 150
102   POKE 34,0: POKE 35,23: HOME
      : PRINT "IT'S TOO DARK TA SE
      E !!": IF L = 15 AND O$(6,3)
```

Listing 1 continued on page 270

Listing 1 continued:

```
      < > "1" AND O$(4,3) < > "
      1" THEN  PRINT "YA HEAR A ST
      RANGE NOISE !
110  POKE 35,24: GOTO 350
120 T$ = "OK": RETURN
140 B = 1: PRINT : PRINT "YA SEE
      : ";: RETURN
150  IF CL = 1 THEN LN = LN - 1: IF
      LN < 1 THEN CL = 0
160 I =  FRE (0):L1 = L
170 B = 0: POKE 35,BD: POKE 34,0:
      VTAB 1: HOME : POKE 35,24: PRINT
      "YER "N$(L,0)".": FOR J = 0 TO
      32: IF  VAL (O$(J,2)) < > L
      THEN 240
175  IF B = 0 THEN  GOSUB 140
180  IF O$(J,3) = "-7" OR O$(J,3)
      = "-2" THEN  PRINT "BURNT "
      ;
190  IF J < > 1 OR  VAL (O$(1,2)
      ) < > L THEN 200
193  IF O$(1,3) = "" THEN  PRINT
      "UNTIED ";: GOTO 200
196  IF O$(1,3) = "-9" THEN  PRINT
      "DEAD ";
200  IF O$(J,3) = "-3" THEN  PRINT
      "SMASHED ";
210  IF L < > 26 OR J < > 32 THEN
      220
213  IF U1 < > 0 THEN  PRINT "UN
      ";
216  PRINT "LOCKED ";
220  IF CL = 1 AND J = 12 THEN  PRINT
      "LIT ";
230  PRINT O$(J,0)". ";
240  NEXT J
250  IF U1 = 1 AND L = 1 THEN  PRINT
      "OPEN TRAP DOOR. ";
260  IF N$(L,1) = "" THEN  PRINT
      : GOTO 330
265  IF B = 0 THEN  GOSUB 140
270  IF L < > 16 THEN 280
273  IF U < > 0 THEN  PRINT "UN"
      ;
276  PRINT "LOCKED ";: GOTO 290
280  IF L < > 17 THEN 290
283  IF U = 1 THEN  PRINT "UNLOCK
      ED ";: GOTO 290
286  PRINT "BLOCKED ";
290  PRINT N$(L,1)".
310  IF L = 17 AND U = 0 THEN N$(
      L,2) = " " +  RIGHT$ (N$(L,2
      ),3)
320  IF L = 16 AND U = 1 THEN N$(
      L,2) = "E" +  RIGHT$ (N$(L,2
      ),3)
330  CALL  - 868: PRINT : IF N$(L
      ,2) = "" THEN 350
335  PRINT "OBVIOUS EXITS : ";: FOR
      I = 1 TO 4:P$ =  MID$ (N$(L,
      2),I,1): IF P$ = "N" THEN  PRINT
      "NORTH ";
336  IF P$ = "S" THEN  PRINT "SOU
      TH ";
337  IF P$ = "E" THEN  PRINT "EAS
      T ";
338  IF P$ = "W" THEN  PRINT "WES
      T ";
340  NEXT : CALL  - 868: PRINT
350 B = 0: PRINT "==============
      ======================
360 BD =  PEEK (37): POKE 34,BD: VTAB
      24: IF L = 9 AND O$(22,2) =
      "11" THEN  PRINT "THAR'S NOI
      SE UP AHEAD.": PRINT "SOUNDS
       LIKE INJUNS.
370  IF L = 9 AND O$(22,2) = "" THEN
      O$(22,2) = "11
390  INPUT " --NOW WHAT?";QM$
410  IF LN < 10 AND CL = 1 THEN  PRINT
      "YER RUNNIN' LOW ON KEROSENE
      .
415  IF QM$ = "SAVE" OR QM$ = "SA
      VE GAME" THEN 2520
420  IF QM$ < > "SCORE" THEN 450

423  IF L < > 6 THEN T$ = "YA GE
      T NOTHIN' FOR BEIN' HERE!": GOTO
      1900
426 Z = 0: FOR I = 14 TO 17: IF O
      $(I,2) = "6" THEN Z = Z + 1
430  NEXT
440  PRINT "YA GOT "Z" TREASURES,
       TOT'LIN "(Z / 4) * 100"%": IF
      Z = 4 THEN  PRINT "YA MADE I
      T!!": GOTO 2220
445 T$ = "YA MISSED SUM TREASURE!
      ": GOTO 1900
450  IF CL = 0 AND L = 15 AND O$(
      6,3) < > "1" THEN  PRINT "Y
      E GAD!": PRINT "YA BEEN BIT
      BY A RATTLER.": PRINT "YER D
      EAD.": GOTO 2220
460  IF L = 17 AND U = 1 AND  RND
      (1) * 9 + 1 < 2 THEN  PRINT
```

```
    "&(%]#&@  CAVE IN !! /:+*@":
     PRINT "THE IRON DOOR'S BLOC
    KED,": PRINT "YER TRAPPED!!"
    :U = 0
480  IF QM$ = "HELP" THEN X =  VAL
    (N$(L,3)): ON X GOSUB 2300,2
    310,2320,2330,2350,2370,2380
    ,2390: GOTO 100
490 X1 =  LEN (QM$): IF X1 < 3 THEN
    T$ = "WHAT?": GOTO 1900
493 X3 = 0: FOR X2 = 3 TO X1:M1$ =
     MID$ (QM$,X2,1): IF M1$ = "
     " THEN X3 = X2:X2 = X1
495  NEXT X2:X2 = X3: IF X3 = 0 THEN
    X2 = X1
500 P$ =  LEFT$ (QM$,3): IF X2 <
     > X1 AND X2 + 3 > X1 THEN 6
    10
501 II =  - 1: FOR I = 0 TO 42: IF
    P$ = R$(I) THEN II = I
502  NEXT : IF II >  - 1 THEN I =
    II: GOTO 520
510  IF X1 = X2 THEN T$ = "WHAT?"
    : GOTO 1900
511 T$ = "SORRY, BUT YA CAN'T " +
     LEFT$ (QM$,X2): IF X2 < X1 THEN
    T$ = T$ +  RIGHT$ (QM$,X1 -
    X2)
512 T$ = T$ + ".": GOTO 1900
520  IF I < 8 AND X1 = X2 THEN  ON
    I + 1 GOSUB 2010,2010,2010,2
    220,680,2020,1920,2000: GOTO
    1900
540 JJ =  - 1:M1$ =  MID$ (QM$,X2
     + 1,3): FOR J = 0 TO 32: IF
     M1$ =  LEFT$ (O$(J,0),3) THEN
    JJ = J
542  NEXT :J = JJ: IF JJ >  - 1 THEN
    630
543  IF M1$ = "IRO" THEN 580
545  IF I = 36 THEN 940
550  IF N$(L,1) = "" THEN 560
552 Z = 1:A = Z:X1 =  LEN (N$(L,1
    )): FOR X2 = 5 TO X1: IF  MID$
    (N$(L,1),X2,1) < > CHR$ (4
    6) AND X2 < > X1 THEN  NEXT
    : GOTO 560
553 M2$ =  MID$ (N$(L,1),Z,3): IF
    M2$ = M1$ THEN 556
554 Z = X2 + 2:A = A + 1: NEXT : GOTO
    560
556 X2 = X1: NEXT :B = A: IF I =
    10 THEN  PRINT "YA SEE NOTHI
    N' SPECIAL.": GOTO 160
558  GOTO 630
560  FOR X = 43 TO 46: IF M1$ = R
    $(X) THEN X = 46: NEXT : GOTO
    650
565  NEXT
570  IF O$(4,3) = "1" OR O$(6,3) =
    "1" THEN  IF I = 23 AND M1$ =
    "SEL" THEN  PRINT "OK": PRINT
    "YER DEAD.": GOTO 2220
580  IF I = 32 THEN  GOSUB 780: GOTO
    1900
590  IF I = 33 THEN  GOSUB 860: GOTO
    1900
600 T$ = "I CAN'T TELL WACHA WANT
    .": GOTO 1900
```

Listing 1 continued on page 272

Listing 1 continued:

```
610 T$ = "I MUST BE DUMB, YA DON'
     T MAKE SENSE.": GOTO 1900
630  IF I < 9 THEN 650
633  IF J < 33 AND J >  - 1 THEN
     B =  VAL (O$(J,2)): IF B <  >
     L AND B > 0 THEN 1890
636  IF J > 32 THEN J = 29
640  ON I - 8 GOSUB 1250,1390,139
     0,1390,1250,1700,1700,1700,1
     700,1820,1820,1250,700,700,1
     080,1060,1060,920,1150,1190,
     1210,730,730,780,860,1250,90
     0,940,1700,1690,1320,1340,18
     20,2500
650  IF I < 9 THEN  ON I + 1 GOSUB
     970,970,970,2220,680,970,192
     0,2000,1320
660  GOTO 1900
680  IF O$(3,3) <  > "1" THEN 189
     0
683  PRINT "OK": FOR I = 13 TO 17
     : IF  VAL (O$(I,2)) =  - L THEN
     T$ = "EUREKA! WE STRUCK GOLD
     ?!??":O$(I,2) =  STR$ (L): RETURN

685  NEXT
686 T$ = "DAG NAB IT!  THAR'S NOT
     HIN' HERE!": RETURN
700  IF J <  > 23 THEN 1060
701  IF L = 14 THEN O$(23,2) = "1
     5": GOTO 120
702  IF L = 15 THEN O$(23,2) = "1
     6": GOTO 120
703  IF L = 16 AND U = 1 THEN O$(
     23,2) = "17": GOTO 120
704  IF L = 17 THEN O$(23,2) = "1
     9": GOTO 120
705  IF L = 19 THEN O$(23,2) = "2
     3":O$(23,3) = "-3
710  GOTO 120
730  IF J = 3 OR J = 4 OR J = 6 OR
     J = 8 OR J = 9 OR J = 11 OR
     J = 12 OR J = 13 OR J = 19 OR
     J = 27 OR J = 28 THEN 740
735  GOTO 1050
740  IF O$(J,3) = "1" THEN IN = I
     N - 1
750 O$(J,3) = "-3":O$(J,2) =  STR$
     (L): GOTO 120
770 T$ = "DON'T HAVTA.": RETURN
780  IF L <  > 16 THEN 800
783  IF U <  > 0 THEN 770
786  IF O$(10,3) = "1" THEN U = 1
     : GOTO 120
788  GOTO 1890
800  IF L <  > 26 THEN 820
803  IF U1 <  > 0 THEN 770
806  IF O$(10,3) = "1" THEN U1 =
     1: RETURN
808  GOTO 1890
820  IF O$(1,3) <  > "1" THEN 840

825  IF O$(0,3) = "2" THEN O$(0,3
     ) = "":O$(0,2) =  STR$ (L): GOTO
     120
830  GOTO 1050
840  IF CL = 1 AND O$(12,3) = "1"
      THEN CL = 0: GOTO 120
860  IF (L = 16 OR L = 17) AND U =
     1 THEN U = 0: GOTO 120
870  IF L = 26 AND U1 = 1 THEN U1
      = 0: GOTO 120
```

```
880  GOTO 1050
900 T$ = "YA HEAR NOTHIN' SPECIAL
     .": RETURN
920  IF L < > 11 OR O$(9,3) < >
     "1" THEN 1320
930  PRINT "THEY TOOK THE FIRE WA
     TER 'N RAN.":IN = IN - 1:O$(
     9,2) = "":O$(9,3) = "":O$(22
     ,2) = "": RETURN
940  IF M1$ = "YOH" THEN T$ = "TU
     RKEY!": PRINT "SORRY, YER IN
      THE WRONG ADVENTURE.": GOTO
     1900
950  GOSUB 120:T$ = T$ + CHR$ (1
     3) + RIGHT$ (QM$,X1 - X2) +
     ".": GOTO 1900
970  IF B = 0 THEN 980
973 L = VAL (N$(L,B + 3)): IF O$
     (1,3) = "1" AND (L = 1 OR L =
     6 OR L = 15) THEN T$ = "HE W
     ON'T GO.":L = L1: RETURN
976  IF L = 17 AND U = 0 THEN L =
     L1: GOTO 1890
978  IF L1 = 26 AND L = 1 AND U1 =
     0 THEN L = L1: GOTO 1890
979  GOTO 1060
980  IF U1 = 1 AND L = 1 THEN L =
     26: GOTO 120
990  IF U1 = 1 AND M1$ = "TRA" AND
     L = 26 THEN L = 1: RETURN
1000  FOR X1 = 1 TO 4:M2$ = MID$
     (N$(L,2),X1,1): IF M2$ < >
      LEFT$ (M1$,1) THEN NEXT X1
     : GOTO 1010
1003  FOR X2 = 43 TO 46: IF M1$ <
      > R$(X2) THEN NEXT X2: GOTO
      1010
1006 L = VAL (N$(L,X1 + 3)): IF
     L < > 0 THEN 1060
1010  IF L = 23 THEN T$ = "IT'S T
     OO SLIPPERY.": RETURN
1020  IF L = 25 THEN L = 26: RETURN

1030  IF L = 26 THEN L = 25: RETURN

1040  IF L = 19 THEN L = 23: PRINT
     "NIGH BROKE M'NECK!!": RETURN

1050 T$ = "SORRY, BUTCHA CAN'T DO
      THAT.": RETURN
1060 B = 0: GOTO 120
1080  IF O$(4,3) < > "1" AND O$(
     6,3) < > "1" THEN 1320
1083  IF J < > 1 THEN 1110
1086 Z = 0: IF O$(J,3) = "1" THEN
     Z = 99
1090 O$(J,3) = "-9":O$(1,2) = STR$
     (L)
1100  IF Z = 99 THEN IN = IN - 1
1110  IF J = 22 THEN PRINT "YA G
     OT ONE!": PRINT "BUT THE RES
     T GOT YOU!": GOTO 2220
1120  IF J = 9 THEN T$ = "YA HIT
     ONE!": RETURN
1130  GOTO 120
1150  IF O$(18,3) < > "1" THEN 1
     890
1152  IF J < 0 THEN 511
1153  IF J = 4 OR (J > 5 AND J <
     11) OR (J > 14 AND J < 18) OR
     J = 22 OR J = 29 OR J > 30 THEN
     1050
```

Listing 1 continued on page 274

Listing 1 continued:

```
1156  IF O$(J,3) = "1" THEN IN =
     IN - 1
1157 O$(J,3) = "-7":O$(J,2) =  STR$
     (L)
1158  IF J > 0 THEN 1060
1160  IF O$(0,3) <  > "-7" THEN 1
     060
1163 O$(0,2) =  STR$ (L): FOR J =
     5 TO 21: IF O$(J,2) = "-1" THEN
     O$(J,3) = "-7"
1170  NEXT : GOTO 1060
1190  IF J <  > 12 THEN 1150
1193  IF O$(J,3) <  > "1" OR O$(1
     8,3) <  > "1" THEN 1150
1195 CL = 1: GOTO 120
1210  IF J = 13 THEN  PRINT "YEEE
     CH!!": PRINT "IT'S KEROSENE!
     ": PRINT "YA JUST POISONED Y
     ERSELF.": GOTO 2220
1220  IF J <  > 9 THEN 1050
1230  PRINT "WHEEEE!!": PRINT "YA
      GOT PLASTERED AND LOST A DA
     Y.": IF CL = 1 THEN LN = LN -
     10
1235  RETURN
1250  IF J > 32 OR J < 0 THEN 126
     0
1253 B =  VAL (O$(J,2)): IF O$(J,
     3) = "2" OR B = L OR B =  -
     1 THEN 1260
1255  IF J < 22 THEN 1890
1257 T$ = "IT AIN'T HERE.": RETURN
1260  IF J > 21 OR J = 1 OR J =  -
     1 THEN T$ = "WHO THE HECK YA
      THINK YA IS?" + C$ + "PAUL
     BUNYON??!  YA AIN'T STRONG '
     NUF.": RETURN
1270  IF O$(J,3) = "-7" THEN T$ =
     "IT'S BURNT UP 'N RUINED.": RETURN
1280  IF IN > 4 THEN T$ = "YA CAN
     'T! YER HANDS 'R FULL.": RETURN

1283  IF O$(J,3) = "1" THEN  PRINT
     "YA ALREADY GOT IT!": RETURN

1286  IF  VAL (O$(J,1)) = 0 AND I
     <  > 16 THEN 1290
1287 IN = IN + 1: IF O$(J,2) = "-
     1" THEN IM = IM - 1:O$(J,2) =
     "":7$(J,3) = "1": GOTO 1290
1288 O$(J,3) = "1":O$(J,2) = ""
1290  IF J <  > 9 AND J <  > 11 AND
     J <  > 2 THEN 120
1293  IF J = 9 THEN  IF O$(8,2) =
     "-6" THEN O$(8,2) = "6
1295  IF J = 11 THEN  IF O$(12,2)
      = "-8" THEN O$(12,2) = "8
1297  IF J = 2 THEN  IF O$(18,2) =
     "-14" THEN O$(18,2) = "14
1300  RETURN
1320  IF O$(J,3) <  > "1" THEN T$
      = "YA DON'T HAVE IT !": RETURN

1325 T$ = "OK":IN = IN - 1:O$(J,2
     ) =  STR$ (L):O$(J,3) = "": RETURN
1340  IF O$(5,3) <  > "1" THEN 18
     90
1350  IF L = 7 THEN L = 8: GOTO 1
     20
1360  IF L = 12 THEN L = 13
1370  GOTO 120
1390  GOSUB 120: ON J + 1 GOTO 14
```



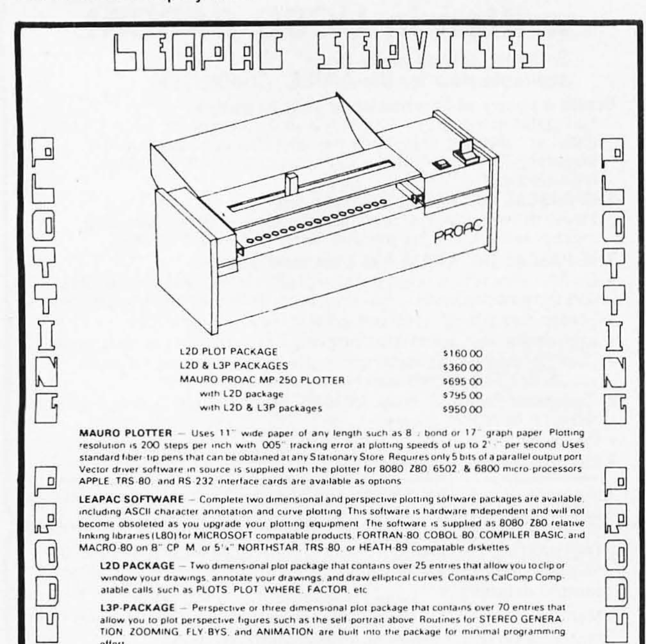
```
     00,1430,1440,1460,1470,1480,
     1490,1460,1460,1500,1510,152
     0,1530,1540,1460,1460,1460,1
     460,1460,1560,1570,1580,1590
     ,1600,1610,1620,1460,1630,14
     60,1460,1460,1640,1460
1395  GOTO 1460
1400  IF  VAL (O$(0,3)) < 1 THEN
     T$ = "THEY'S LUMPY OLE LEATH
     ER SADDLEBAGS.": RETURN
1410  PRINT "THEY HOLD ";: IF IM =
     0 THEN  PRINT "NOTHIN'.":T$ =
     "": RETURN
1415  FOR I = 6 TO 22: IF O$(I,2)
     = "-1" THEN  PRINT " "O$(I,
     0)",";
1420  NEXT :T$ =  CHR$ (8) + ".":
     RETURN
1430 T$ = "YA SEE A WEARY OLD GRE
     Y MULE.": RETURN
1440 T$ = "IT'S AN OLE TORN SACK.
     ": IF O$(18,2) = "-14" THEN
     O$(18,2) = "14"
1450  RETURN
1460 T$ = "YA SEE NOTHIN' SPECIAL
     .": RETURN
1470 T$ = "IT'S AN OLD WINCHESTER
      SINGLE-SHOT.": RETURN
1480 T$ = "LOOKS LIKE A MAP TA TH
     ' LOST DUTCHMAN'S MINE! THAR
     'S A SKETCH OF SUM BOULDERS.
     ": RETURN
1490 T$ = "NOTHIN' SPECIAL," + C$
      + "JUS' A LOADED SIX SHOOTE
     R.": RETURN
1500  IF O$(8,2) = "-6" THEN T$ =
     "LOOKS LIKE SUMTHIN'S 'HIND
     THE BOTTLES.":O$(8,2) = "6":
      RETURN
1505  GOTO 1460
1510 T$ = "THAR'R 3 KEYS, TIED WI
     TH A LEATHER STRAP": RETURN

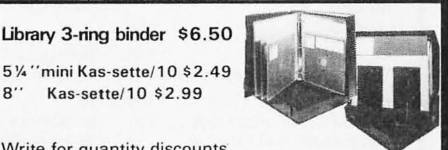
1520  IF O$(12,2) = "-8" THEN T$ =
     "LOOKS LIKE THAR'S GLASS UND
     ER 'UM.":O$(12,2) = "8": RETURN

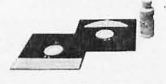
1525  GOTO 1460
1530 T$ = "IT'S AN OLE KEROSENE L
     AMP," + C$ + "FULL TA THE '"
      +  STR$ (LN) + " TURNS LEFT
     ' MARK.": RETURN
1540  IF I = 11 THEN T$ = "IT SEZ
      'KEROSENE.'": RETURN
1550 T$ = "THAR'S WRITING ON IT."
      : RETURN
1560  IF O$(20,2) = "-17" THEN O$
     (20,2) = "17":T$ = "IT'S A M
     ESSAGE !": RETURN
1565  GOTO 1460
1570  IF I = 11 THEN T$ = "IT SEZ
     :" + C$ + "BRING TREASURES T
     O SALOON, SAY 'SCORE.'": RETURN

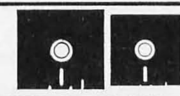
1575  GOTO 1550
1580  IF I = 11 THEN T$ = "IT SEZ
     :" + C$ + "WATCH FOR OTHER R
     IDER FANTASY CREATIONS ADVEN
     TURES!": RETURN
1585  GOTO 1550
1590 T$ = "THEY'S A SAVAGE LOOKIN
```

Listing 1 continued on page 276









Listing 1 continued:

```
     ' BAND," + C$ + "'N THEY SEE
     N YA!": RETURN
1600 T$ = "JUS' AN OLE ORE CART F
     ULL O' ROCKS.": RETURN
1610  IF O$(5,2) = "-25" THEN O$(
     5,2) = "1":T$ = "THAR'S SUMT
     HIN' HERE!!": RETURN
1615  GOTO 1460
1620  IF I = 11 THEN T$ = "IT SEZ
     :" + C$ + "WELCOME TO FRONTI
     ERTOWN.": RETURN
1625  GOTO 1550
1630  IF O$(10,2) = "-6" THEN O$(
     10,2) = "6":T$ = "THAR'S A S
     ET OF KEYS THAR!": RETURN
1635  GOTO 1460
1640 B =  INT ( RND (1) * 3 + 1):
      ON B GOTO 1650,1660,1670
1650 T$ = "IT'S A BARREL CACTUS."
     : RETURN
1660 T$ = "IT'S A CHOLLA CACTUS."
     : RETURN
1670 T$ = "IT'S A SAGUARO CACTUS.
     ": RETURN
1690  IF J = 4 AND I = 38 THEN 17
     80
1700  IF J < > 1 OR  VAL (O$(1,3
     )) < 0 THEN T$ = "SORRY, B'
     THAT AIN'T POSSIBLE.": RETURN

1710  IF I < > 38 THEN 1720
1715  IF O$(1,3) = "" THEN T$ = "
     TENDARFOOT! YA HAV'TA LEAD '
     IM FIRST.": RETURN
1717  GOTO 1780
1720  IF O$(1,3) = "1" THEN 1320
1723  IF O$(7,3) = "1" THEN  IF I
      < > 16 THEN T$ = "TRY 'LEA
     D.'": RETURN
1730  ON I - 13 GOTO 1740,1750,17
     60,1770
1740 T$ = "HE GOT AWAY FROM YA.":
      RETURN
1750 T$ = "YER TOO SLOW, HE GOT A
     WAY.": RETURN
1760  IF O$(7,3) < > "1" THEN T$
      = "BAD LUCK, YA TRIPPED AND
      HE RUN OFF.":O$(1,3) = "":O
     $(1,2) =  STR$ (L): RETURN
1763  IF O$(1,3) = "" THEN 1280
1766  GOTO 1320
1770 T$ = "HE BUCKED YA OFF.": RETURN

1780  INPUT "WITH WHAT?";QM$: IF
     J = 4 THEN 1800
1782  IF  LEFT$ (QM$ + " ",3) < >
     "SAD" THEN T$ = "IT FELL OFF
     ." + C$ + "HE GOT AWAY.":O$(
     1,3) = "":IN = IN - 1:O$(1,2
     ) =  STR$ (L): RETURN
1790  IF O$(0,3) = "1" THEN O$(0,
     3) = "2":IN = IN - 1: GOTO 1
     060
1795  GOTO 1320
1800  IF  LEFT$ (QM$ + " ",3) < >
     "BUL" THEN 1050
1805  IF O$(8,3) < > "1" OR O$(4
     ,3) < > "1" THEN 1320
1810  GOTO 120
1820  IF O$(J,3) < > "1" THEN 13
     20
1822  INPUT "ON OR IN WHAT? (IE '
```



```
     ON TABLE') ?";QM$:P$ =  LEFT$
     (QM$ + " ",2): IF P$ <  > "I
     N" AND P$ <  > "ON" THEN T$ =
     "HUH?": RETURN
1830 M1$ =  MID$ (QM$,4,3)
1840  IF P$ <  > "ON" THEN 1850
1841  IF M1$ = "MUL" THEN 1790
1843  IF J <  > 13 THEN 1320
1845  IF LM = 0 THEN T$ = "IT'S E
     MPTY.": RETURN
1847 LM = 0: GOTO 1320
1850  IF M1$ <  > "SAD" THEN 1860

1852  IF J < 5 OR J = 19 OR J = 2
     2 THEN T$ = "SORRY, IT DON'T
      FIT.": RETURN
1855  IF IM > 4 THEN T$ = "THE BA
     GS 'R FULL.": RETURN
1857 O$(J,2) = "-1":O$(J,3) = "":
     IN = IN - 1:IM = IM + 1:T$ =
     "OK": RETURN
1860  IF M1$ = "MUL" THEN T$ = "Y
     A GOT KICKED !": RETURN
1870  IF M1$ <  > "LAN" THEN 1050

1872  IF O$(13,3) <  > "1" OR O$(
     12,3) <  > "1" THEN 1320
1875  IF LM = 50 THEN LN = LN + 5
     0:LM = 0: GOTO 120
1880 T$ = "JAR'S EMPTY.": RETURN

1890 T$ = "YA CAN'T DO THAT... YE
     T!
1900  PRINT T$:T$ = "": GOTO 100
1920  PRINT "YA GOT WITH YA: ";: IF
     IN = 0 AND O$(1,3) <  > "1" THEN
     T$ = "NOTHIN'": RETURN
1930 B =  VAL (O$(0,3)):X1 = B: IF
     B <  > 1 THEN 1940
1933  PRINT : PRINT O$(0,0)", CON
     TAINING: ";: FOR I = 1 TO 22
     : IF O$(I,2) = "-1" THEN  PRINT
     O$(I,0)". ";:X1 = 2
1936  NEXT : IF X1 <  > 2 THEN  PRINT
     "NOTHIN'! ";
1940  IF O$(1,3) = "1" THEN  PRINT
     : PRINT "THE MULE, WHICH YER
      LEADIN. ";: IF B = 2 THEN  PRINT
     "(CARRYIN' SADDLEBAGS) ";
1950  PRINT :X1 = 0: FOR I = 2 TO
     22: IF  VAL (O$(I,3)) < 1 THEN
     1970
1955  IF CL = 1 AND I = 12 THEN  PRINT
     "LIT ";
1960  PRINT O$(I,0)". ";
1970  NEXT
1980 T$ = "": RETURN
2000  IF L = 19 THEN  HOME : PRINT
     "

      YA FELL 100 FEET 'N LANDED
     ON ROCKS.": PRINT "
                             YER DEAD.
     ": GOTO 2220
2005  IF J = 23 OR J = 32 OR M1$ =
     "P" THEN T$ = "OK": RETURN
2006  GOTO 1050
2010 T$ = "WHERE?": RETURN
2020  IF L = 25 THEN L = 26: GOTO
     120
2030  IF L = 26 THEN L = 25
2040  GOTO 120
2100  DATA ,,,,,,,,IN A MINER'S S
```

Listing 1 continued on page 278

Listing 1 continued:

```
      HACK,WINDOW. DOOR,,1,3,3,,,I
      N A DESERT,ROAD. MOUNTAINS.
      DESERT,WNES,2,4,2,2,2,ON A D
      IRT PATH,MINER'S SHACK. ROAD
      . MOUNTAINS," W  ",5,1,4,2,2

2110  DATA ON A DIRT ROAD,MOUNTAI
      NS. PATH. DESERT. TOWN,NE S,
      2,7,3,2,5,IN A GHOST TOWN,SA
      LOON," N  ",1,6,4,,,IN A SAL
      OON,,W   ,1,5,,,
2120  DATA AT THE SUPERSTITION MO
      UNTAINS,ROAD. DESERT,S N ,4,
      4,2,2,2,AT WEAVER'S NEEDLE,,
      NS  ,1,9,7,,
2130  DATA IN A NARROW DEFILE,BUS
      HES. CAVES,"  NS",1,11,10,12
      ,8,IN A SMALL CAVE,,E   ,1,9
      ,,,,BEHIND A BUSH,BUSH.,W
      ,1,9,,,,IN A BOX CANYON,BUSH
      ES. TREES. BOULDERS,"   S",4
      ,12,12,12,9
2140  DATA IN FRONT OF A HIDDEN M
      INE,MINE SHAFT,ESNW,8,14,12,
      12,12,IN THE MOUTH OF A DIM
      MINE,MINE SHAFT,EW  ,1,15,13
      ,,,IN A MINE,DARK TUNNEL,EW
       ,6,16,14,,
2150  DATA AT THE END OF A TUNNEL
      ,IRON DOOR," W  ",1,17,15,,,
      IN A LARGE CHAMBER,IRON DOOR
      ,WNES,1,16,19,18,20,IN A MAZ
      E OF TUNNELS,,NSEW,6,18,18,1
      8,18,IN FRONT OF A PIT,DARK
      HOLE," S  ",7,23,17,,
2160  DATA AT AN INTERSECTION,,"
      SNW",6,,22,17,21,IN A DEAD E
      ND TUNNEL,,E   ,8,20,,,,IN A
       BLOCKED TUNNEL,,N   ,8,20,,
      ,,AT THE BOTTOM OF A SHAFT,W
      ALL,S   ,8,24,,,
2170  DATA IN A TUNNEL,,NS   ,6,23
      ,25,,,AT THE END OF A TUNNEL
      ,LADDER," N  ",6,26,24,,,AT
      THE TOP OF A LADDER,,,6,1,25
      ,,
2180  DATA SADDLEBAGS,2,1,MULE,,3
      ,BURLAP SACK,4,14,SHOVEL,4,1
      ,RIFLE,4,1,MAP,1,-25,GUN,1,-
      1,CARROTS,1,-1,BOX OF RIFLE
      BULLETS,1,-6,WHISKEY BOTTLES
      ,2,6,KEYS,1,-6,PILE OF BONES
       (MINE),2,8
2190  DATA LANTERN,2,-8,JAR OF LI
      QUID,1,-11,*SPANISH COINS*,1
      ,-10,*TOURQUOISE*,1,-23,#SIL
      VER#,1,-21,#GOLD#,1,-22,MATC
      HES,1,-14,CRATES,3,17,NOTE,1
      ,-17,PAPER,1,6,INDIANS,,11
2200  DATA ORE CART,,14,BED,,1,SI
      GN,,5,BROKEN GLASS,,6,TABLES
      ,,6,CHAIRS,,6,ROCKS,,10,WOOD
      EN RAILS,,15,CACTUS,,2,TRAP
      DOOR,,26
2210  DATA GO ,ENT,RUN,QUI,DIG,CL
      I,INV,JUM,DRO,GET,EXA,REA,LO
      O,MOV,CAT,CHA,LEA,RID,PUT,PL
      A,PIC,PUS,PUL,SHO,OPE,CLO,GI
      V,BUR,LIG,DRI,BRE,HIT,UNL,LO
      C,TAK,LIS,SAY,FEE,LOA,UNT,FO
      L,POU,EAT,NOR,SOU,EAS,WES
```

Listing 1 continued on page 280

Listing 1 continued:

```
2220  VTAB 24: INPUT "DO YA WANT
     TA TRY AGIN?";QM$: IF  LEFT$
     (QM$ + " ",1) = "Y" THEN  RUN

2230  POKE 34,0: POKE 35,24: HOME
     : NEW
2300  PRINT "TRY EXAM'NIN THIN'S.
     ": RETURN
2310  PRINT "ROADS GO PLACES.": RETURN

2320  PRINT "MAYBE THE TRAIL GOES
      SUMWHAR.": RETURN
2330  IF O$(5,3) <  > "1" THEN  PRINT
     "YA GOT A MAP?": RETURN
2340  PRINT "TRY 'FOLLOW.'": RETURN

2350  IF  VAL (O$(1,2)) = L THEN
      PRINT "THE MULE LOOKS THIN.
     ": RETURN
2360  GOTO 2300
2370  PRINT "KEEP GOIN'.": RETURN

2380  PRINT "IT'S SLIPRY, BUTCHA
     MIGHT MAKE IT DOWN.": RETURN

2390  PRINT "THIS HERE'S A MINE,
     YA KNOW.": RETURN
2500  IF J = 7 THEN T$ = "THEY TA
     STE PURTY GOOD.": RETURN
2510 T$ = "CAN'T DO THAT... WEIRD
     O !": RETURN
2520  INPUT "SURE?";QM$: IF  LEFT$
     (QM$ + " ",1) <  > "Y" THEN
     390
2530  INPUT "NAME?";QM$:QM$ = "LD
     G/" + QM$: ONERR  GOTO 4100
2535  PRINT "OPEN "QM$: PRINT "WR
     ITE "QM$
2540  PRINT L","CL","LN","IN","LM
     ","U","U1","IM
2541  FOR X = 0 TO 32: PRINT O$(X
     ,1)","O$(X,2)","O$(X,3): NEXT

2550  PRINT "CLOSE "QM$: POKE 216
     ,0: PRINT "SAVED!": GOTO 390

4000  POKE 216,0: PRINT "CLOSE "Q
     M$:EE =  PEEK (222): IF EE =
     2 OR EE = 3 OR EE = 11 THEN
      PRINT "BAD NAME. TRY ANOTHE
     R.": GOTO 80
4010  IF EE = 6 THEN  PRINT "NO F
     ILE NAMED "QM$: GOTO 70
4020  PRINT ">>> DISK PROBLEM. ER
     ROR #"EE: GOTO 70
4100  POKE 216,0: PRINT "CLOSE "Q
     M$:EE =  PEEK (222)
4110  IF EE = 2 OR EE = 3 OR EE =
     11 THEN  PRINT "BAD NAME. TR
     Y ANOTHER.": GOTO 2520
4120  IF EE = 4 THEN  PRINT "DISK
      WRITE PROTECTED!": GOTO 252
     0
4130  IF EE = 9 THEN  PRINT "DISK
      FULL!": PRINT "DELETE"QM$: GOTO
     2520
4140  IF EE = 10 THEN  PRINT "FIL
     E LOCKED! (AND I DIDN'T DO I
     T!)": GOTO 390
4150  PRINT ">>> DISK PROBLEM. ER
     ROR #"EE: GOTO 390
9999  END
```

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. . . the next few years will see a massive influx of computers into serious war-gaming.
— *The General* volume 16, number 3

Ever since the advent of the war game as a hobby in the early 1950s, the marriage of the war game and the computer has been a recurring topic of discussion in periodicals and at gaming conventions. Certain aspects of designing and playing war games appeared to be natural applications for the computer—recording and manipulating large quantities of data, simulating incomplete intelligence in a two-player game, and recording and storing games in progress. The design and publication of war games is, however, a commerical field like any other, and until recently, the high cost of the hardware and software involved sent the average war gamer back to his manual unit-strength roster sheets with a sigh of "what if."

Although *Star Trek* and other computer "war games" have been in existence for some time, attempts to apply computers to a serious historical-simulation game are relatively recent. (The quotation above, taken from an article entitled "Panzer Dreamer," was published as recently as September 1979.) Simulations Publications Inc (SPI), a major war game publisher, announced in April 1979 that it would soon market a line of Radio Shack TRS-80 "game assistance" programs that could be used to speed up manual play of specific SPI games. SPI has also designed and published some general-purpose software including a range algorithm for use with the company's standard hex-grid maps.

In January 1980, however, the small California firm of Strategic Simulations Inc published a game called *Computer Bismarck*—and the war game hobby entered the computer age. This game represents a milestone in the development of commerical war games.

At a Glance

Name
Computer Bismarck

Type of package
Historical-simulation game

Manufacturer
Strategic Simulations Inc
POB 5161
Stanford CA 94305
(415) 494-0557

Price
$59.95

Format
5-inch floppy disk

Language
Applesoft BASIC

Computer
Apple II with 48 K bytes of memory and one disk drive

Documentation
Sixteen-page booklet, 8½ by 11 inches (22 by 28 cm), plus printed charts

Audience
Game enthusiasts, high school and older

Additional comments
A somewhat different version for the Radio Shack TRS-80 with 16 K bytes of memory and a cassette interface is available for $49.95

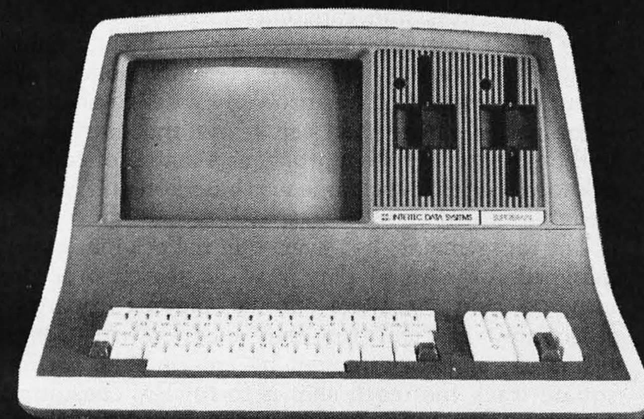
The Game

Computer Bismarck simulates the breakout of the German battleship Bismarck into the North Atlantic in 1941, and the massive British naval and air effort to locate and sink the Bismarck. (The version for an Apple II with one disk drive and 48 K bytes of memory is the one being reviewed here.) The game can be played in two modes; as a two-player game with one player commanding the Bismarck and the other the British forces, or as solitaire, with the player commanding the British forces against the wily efforts of "Otto von Computer." In either case, the objectives are the same: the British must sink or damage the Bismarck while protecting their merchant convoy routes to and from North America, and the Germans must avoid being sunk while disrupting convoys and possibly sinking British warships.

The game begins with all forces located as they were at 1200 hours on May 22, 1941. Play proceeds in turns, with each turn representing four hours of time. During a turn, each player enters movement and search commands by keyboard for each of his ships and aircraft. A color map, displayed on the computer video screen, shows the locations of friendly forces and of enemy forces that were spotted in the previous turn.

After all orders have been entered, the computer carries out all movement simultaneously and determines whether opposing forces have sighted each other. Combat can result when opposing forces find themselves in the same map square. Combat resolution (including

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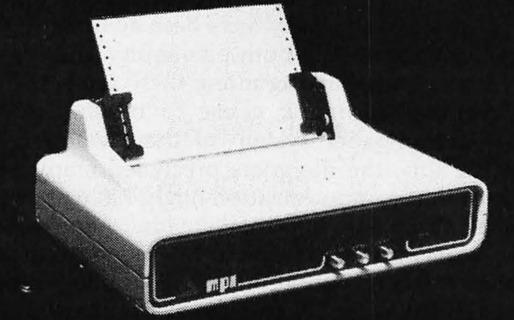
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aerial bomb/torpedo attacks, surface gunfire/torpedo attacks, and submarine attacks) is done by the computer, and damage points are assigned to the forces involved as appropriate. Damage cumulatively reduces the speed, firepower, and/or the structural integrity of a ship. The number of hits required to sink a ship varies with the characteristics of the particular ship and the amount of damage it has sustained in previous combat.

Once combat resolution is completed, another turn begins and the cycle is repeated. Factors such as weather (which affects searching), ammunition expenditure, and reinforcements are monitored by the computer and introduced into play as appropriate. The game ends when the Bismarck is sunk, when one player has accumulated a lead of 30 victory points, or after the 0800, May 27, 1941, turn.

Physical Description

Along with the program floppy disk, the *Computer Bismarck* package includes two plastic-coated mapboard charts for move plotting, a sixteen-page rulebook (containing strategy suggestions and historical background, as well as the game rules), a set of data charts, a setup sheet, and two grease pencils for use with the mapboard charts. The printing and graphics are of professional quality throughout. The components are packaged in an unnecessarily large, but attractively illustrated, box. All in all, the game is an excellent physical product. A minor irritation with the graphics is the use of three-digit twenty-four-hour clock times on the turn record chart (eg: "400" instead of the more proper "0400" to represent 4 AM).

Game Evaluation

The promotional literature for *Computer Bismarck* claims that "without the drudgery of the organizational overhead of paper-and-pencil games, your mind is free to develop and test sophisticated search, combat, and logistics strategies . . ." (*Campaign*, number 79). Regrettably, this claim is largely untrue. Although *Computer Bismarck* does relieve the player of many of the paperwork aspects of conventional war games, it introduces new problems that can actually increase the time required to complete a single turn.

The mechanics of *Computer Bismarck* are based almost entirely upon those of the conventional war game *Bismarck*, published in 1979 by the Avalon Hill Company. While the designers of *Computer Bismarck* wisely chose not to adapt the detailed combat mechanics of the Avalon Hill game, the movement and search procedures, orders of battle, and capability factors assigned to the ships and aircraft are derived almost directly from the Avalon Hill version. There is certainly nothing wrong about this; indeed, it was probably wiser to adapt an existing design rather than use a new and untried system (although it would seem proper as a matter of courtesy to acknowledge that the game was based on an Avalon Hill design).

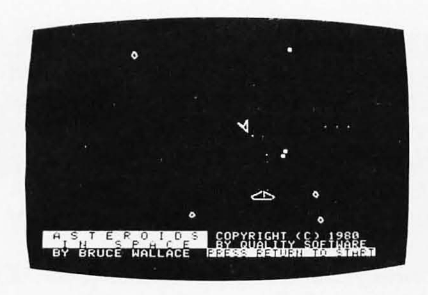
The fact remains, however, that the original game was designed for manual play, and its search procedure—moving ship counters on a playing board—was reasonably efficient for that medium. In *Computer Bismarck*, ships are moved by entering the square-by-square track that each ship is to follow, consulting the mapsheet each time to verify the square coordinates and checking the rules for convoy destinations and other details. This can be rather time-consuming, as the British frequently have thirty-plus ships in play, not to mention aircraft. It also causes a player to become mired in the details of individual ship movement to the exclusion of strategic considerations. *Computer Bismarck* also perpetuates the irritating system of ship movement rates which, in the Avalon Hill original, was apparently scaled so that the map-board would fit exactly into the box.

The failings of *Computer Bismarck* can be summarized by saying that it does not take advantage of the possibilities offered by the computer. For example, it would have been relatively easy to design a movement system based on the *target square* principle; ie: a ship would be ordered to proceed to square X and patrol there until further orders are given. The convoys could also be "programmed" to steam toward their destinations unless ordered otherwise (eg: to avoid the Bismarck). These changes would also have made the game much more realistic. Also, the *task force* system used in the Avalon Hill game could easily have been adapted to the computer version, increasing both playability and realism.

Instead of thinking along these lines, the designers of *Computer Bismarck* chose to retain the conventional pencil-and-paper system of the Avalon Hill game; by doing this, the designers precluded many of the advantages that computerization might have provided. It is difficult to believe that they couldn't have done better.

In all fairness, it should be pointed out that the computer version does offer one unique advantage: the possibility of solitaire play. Preliminary play testing indicates that "Otto von Computer" is indeed a skillful op-

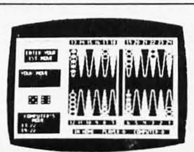
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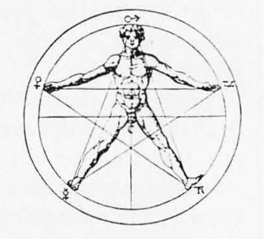
On Diskette - $19.95



FASTGAMMON™ By Bob Christiansen.
Sound, hi res, color, and musical cartoons have helped make this the most popular backgammon playing game for the Apple II. But don't let these entertaining features fool you — FASTGAMMON plays serious backgammon. Runs on any Apple II with at least 24K of RAM.

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ASTROAPPLE™ by Bob Male.
Your Apple computer becomes your astrologer, generating horoscopes and forecasts based on the computed positions of the heavenly bodies. This program offers a delightful and stimulating way to entertain friends. ASTROAPPLE produces natal horoscopes (birth charts) for each person based on his or her birth data. Any two people may be compared for physical, emotional, and intellectual compatibility. The program is written in Applesoft BASIC with machine language subroutines. It requires either RAM or ROM Applesoft and at least 32K of memory.



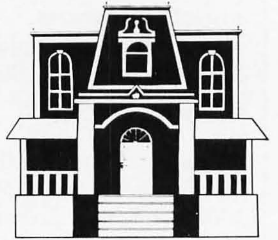
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FRACAS™ by Stuart Smith.
A fantastic adventure game like no other! Up to eight players can participate in FRACAS at the same time. Journey in the land of FAROPH, searching for hidden treasure while warding off all sorts of unfriendly and dangerous creatures. You and your friends can compete with each other or you can join forces and gang up on the monsters. Your location is presented graphically and sound effects enliven the battles. Save your adventure on diskette or cassette and continue it at some other time. Both integer BASIC and Applesoft versions included. Requires at least 32K of RAM.

Cassette - $19.95 **Diskette - $24.95**

BENEATH APPLE MANOR™ by Don Worth.
Descend beneath Apple Manor into an underground maze of corridors, rooms, and secret passages in quest of rich and powerful treasures. The dungeon complex consists of many floors, each lower level more dangerous than the last. If you can reach the lowest level, you may even find the ultimate object of your quest, the fabled golden apple of Apple Manor. Strategy is extremely important as you deal with a variety of monsters, each with its own characteristics. Written in integer BASIC with machine language subroutines. Requires integer BASIC and at least 16K of RAM on cassette or 32K of RAM on diskette.



Cassette - $14.95 **Diskette - $19.95**

BATTLESHIP COMMANDER™ by Erik Kilk and Matthew Jew.





A game of strategy. You and the computer each start out by positioning five ships of different sizes on a ten by ten grid. Then the shooting starts. Place your volleys skillfully — a combination of logic and luck are required to beat the computer. Cartoons show the ships sinking and announce the winner. Sound effects and flashing lights also add to the enjoyment of the game. Both Applesoft and integer BASIC versions are included. Requires at least 32K of RAM.

Cassette - $14.95 **Diskette - $19.95**

BABBLE™ by Don Worth.
Have fun with this unique software. You write a story, entering it as a BABBLE program. As you write the story you specify certain words to be selected by the computer or entered from the keyboard at execution time. Run the program and watch BABBLE convert your story into an often hilarious collection of incongruities. The ways in which BABBLE can entertain you are limited only to your imagination. You can compose an impressive political speech or write poetry. You can plan a dinner menu. You can even form images on the screen or compose musical tunes with the help of BABBLE. The cassette version requires at least 16K of RAM and the diskette version requires at least 32K of RAM. BABBLE is written in machine language and runs on any Apple II computer.

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BABBLE

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L I N K E R

LINKER by Don Worth.
Turn your Apple II or Apple II Plus into a powerful and productive software development machine with this superb linking loader/editor package. LINKER does the following and much more:

- Dynamically loads and relocates suitably prepared machine language programs anywhere in RAM.
- Combines a main program with subroutines. You can assemble a subroutine once and then use it with as many main programs as you wish.
- Produces a map of all loaded routines, giving their location and the total length of the resulting module.
- Contains a library of subroutines including binary multiplication and division, print text strings, delay, tone generator, and random number generator.

Linker works with virtually any assembler for the Apple II. Requires 32K of RAM and one disk drive.

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Manual Only - $19.95



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ponent; one hopes that he has enough crafty schemes in his repertoire to keep the game from becoming predictable.

Summary

● The field of computer war games has vast potential, and it is perhaps unfair to expect the first published example to be a fully developed product. Others, much improved, are certain to follow; as of this writing, Avalon Hill has announced the availability of four "war games for home computers." (One of them, entitled *North Atlantic Convoy Raider*, is described as "a computer simulation of the Bismarck convoy raid of 1941 . . ..") It is likely that *Computer Bismarck* will be remembered as the *Tactics II* of computer gaming—somewhat crude, but a fine effort and definitely a first.

Conclusions

● *Computer Bismarck* allows solitaire play against the computer. This a great advantage for the war gamer who cannot find suitable opponents.

● The game is very attractively produced, including plastic-coated mapboard charts and a well-designed rulebook organized in much the same way as rulebooks from other war game publishers. This adds considerably to the pleasure in playing the game.

● Movement of pieces in this game, which must be done one piece at a time, is time-consuming and tedious. ■

War-Gaming—The Hobby

Shortly before the First World War, the noted science-fiction writer HG Wells published a book entitled Little Wars. *It contained a set of rules for simulating historical battles and campaigns using model soldiers on tabletop battlegrounds. From that point on, miniature war games acquired a troop of devoted followers.*

A new type of commercial war game was introduced in 1953, when Charles S Roberts published Tactics. Tactics *was a board game in which the opposing forces, represented by cardboard unit counters, were maneuvered over a gridded map. Each unit was rated according to its combat and movement ability, and battles were resolved by comparing the strengths of opposing forces and applying a luck factor via die roll.*

Tactics *was quite successful (a revised version,* Tactics II, *is still on the market today), and other games soon followed. The majority of the early titles dealt with historical actions such as Gettysburg, Waterloo, and the Battle of the Bulge. The Avalon Hill Company, founded by Roberts in 1958, was for many years the only professional publisher of commercial war games. In 1970, Simulations Publications Inc began producing games and introduced a number of innovative design concepts. Avalon Hill and SPI continue to be the giants of the war-game industry, although a number of smaller firms have since appeared.*

There are currently several hundred war game titles in print, and sales are climbing toward a million games per year. Game topics range from the campaigns of Alexander and Caesar to World War II, Vietnam, and even to the intergalactic struggles of the distant future.

Information about the war-gaming hobby can be obtained from the many publications on the subject. A few of the most useful sources are listed below:

Book:

The Comprehensive Guide to Board Wargaming, *by Nicholas Palmer, published in paperback by McGraw-Hill, 1979, is an excellent introduction to the subject, although some of the game reviews are already dated.*

Magazines:

Campaign *(POB 896, Fallbrook CA 92028) is a respected source for game reviews, strategy articles, and other features.*

The General *(published by the Avalon Hill Company, 4517 Harford Rd, Baltimore MD 21214) is limited to coverage of Avalon Hill games only, but it is very good on the subjects it covers.*

Strategy and Tactics *(published by Simulations Publications Inc, 257 Park Ave S, New York NY 10010) offers a complete, ready-to-play war game in each issue, as well as historical articles and general gaming information. SPI also publishes* Moves, *which is devoted mainly to game design and strategy, and* Ares, *which covers the relatively new field of science-fiction/fantasy war games.*

Programming Quickies

Monster Combat

Lee Chapel, 2349 Wiggins, Springfield IL 62704

In the game *Monster Combat,* you attempt to win treasure from various loathsome creatures and leave the forest with as much treasure as possible—without getting killed in the process. This program, as shown in listing 1, was written in BASIC on a KIM microprocessor and uses less than 4 K bytes of memory. It is easy to change to almost any other form of BASIC.

In the game, you are placed at a randomly chosen location in a forest with a certain combat strength that is randomly determined. Also, you encounter monsters guarding various tempting treasures and are given a choice of fighting them, running from them, or bribing them; greed and wit are certainly tested here.

To fight the monster, enter a 1. When the program asks you for the number of combat points you wish to use, enter any number smaller than your combat strength (ie:

Listing 1: *Listing for the* Monster Combat *program. This program is written to run on a KIM-1 microcomputer with BASIC and 4 K bytes of memory. It can also be modified to run on a different machine or to generate a larger forest to explore.*

```
1 REM        MONSTER COMBAT
2 REM WRITTEN BY LEE CHAPEL 6/15/80
5 DIMA(10,10):PRINTTAB(20)"MONSTER COMBAT"
10 FORI=1TO9:FORJ=1TO9:A(I,J)=1:IFRND(1)>.75
     THENA(I,J)=2
13 NEXT:NEXT
15 X=INT(RND(1)*6+2):Y=INT(RND(1)*6+2)
17 A(X,Y)=5:C=INT(RND(1)*1501+500)
20 GOSUB900
25 PRINT"YOUR COMBAT STRENGTH IS"C:GOSUB400:
     IFI>11THEN25
30 IFM=0THENPRINT"YOU GET THE TREASURE FREE":
     GOTO495
33 IFM=100ANDN=1THEN880
35 INPUT"DO YOU (1)FIGHT,(2)RUN, OR (3)BRIBE";K
40 ONKGOTO300,350,635
300 INPUT"HOW MANY COMBAT POINTS DO YOU WISH
     TO USE";K
305 IFK>CTHENGOSUB600:PRINTC"COMBAT POINTS":
     GOTO300
310 I=INT(RND(1)*1001):L=2:C=C-K:K=K-.01*Q
315 FORH=1000TO0STEP-50:IFL*M<=KANDH>=ITHEN490
320 L=L-.1:NEXT
325 PRINT"THE MONSTER KILLED YOU.";
330 PRINT"YOU LOSE EVERYTHING":PRINT"DO YOU WISH TO
     TRY AGAIN";
335 INPUTX$:IFLEFT$(X$,1)="Y"THENRUN
340 PRINT:PRINT"SO LONG.BETTER LUCK NEXT TIME":END
350 I=INT(RND(1)*12):IFI=11THEN325
```

Listing 1 continued on page 290

INTRODUCING

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■ Permits multiple named program modules having local variables and identifiers. Modules are reentrant, position independent and ROMable.

■ Additional control statements for structured programming: IF ... THEN ... ELSE, FOR ... NEXT, REPEAT ... UNTIL, WHILE ... DO, LOOP ... ENDLOOP, EXITIF ... ENDEXIT.

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■ Operates in "batch" mode *or* interactive line-by-line mode.

■ Facilities for generation of OS-9™ memory modules and system calls.

■ Formatted listings include syntax *and* context error checking.

■ Runs on OS-9™ Level One or Level Two.

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Facilitates testing and debugging of machine- language programs.

■ Includes common "monitor" functions: memory examine/change, breakpoints, display/change registers, etc.

■ Calculator mode evaluates arithmetic expressions in hex, decimal or binary.

■ Access to system commands.

■ Available on ROM, disk or cassette tape.

☐ Disk or tape $35.00

☐ ROM (2716) $50.00

BASIC 09 is a trademark of Motorola. OS-9 is a trademark of Motorola and Microware®. UNIX is a trademark of Bell Telephone Laboratories.

Most software is available on ROM, diskette and tape in versions for many popular 6809 computers. Source listings and yearly maintenance/update service are sold separately for most programs.

*Specify manufacturer and type of CPU and I/O controllers. Contact Microware® for specific availability.

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Listing 1 continued:

```
355 FORH = 0TO10:IFH*10>MANDH< = ITHEN375
360 NEXT:GOTO685
375 A = X:B = Y
380 X = INT(RND(1)*3 - 1) + A:Y = INT(RND(1)*3 - 1) + B
385 IFA(X,Y) > 1THEN380
390 IFA(X,Y) = 0THEN1000
395 A(A,B) = 1:A(X,Y) = 5:IFI< > 12THEN20
397 RETURN
400 I = INT(RND(1)*14 + 1):M = I*10:IFI< 11THENPRINT"A  ";
405 ONIGOTO410,413,415,417,420,421,423,425,427,429,430,
    750,700,950
410 PRINT"MINOTAUR";:GOTO450
413 PRINT"CYCLOPS";:GOTO450
415 PRINT"ZOMBIE";:GOTO450
417 PRINT"GIANT";:GOTO450
420 PRINT"HARPY";:GOTO450
421 PRINT"GRIFFIN";:GOTO450
423 PRINT"CHIMERA";:GOTO450
425 PRINT"DRAGON";:GOTO450
427 PRINT"WYVERN";:GOTO450
429 PRINT"BASILISK";:GOTO450
430 PRINT"NOTHING";:M = 0
450 PRINT" IS GUARDING ";:I = INT(RND(1)*7 + 1)
455 ONIGOTO460,461,463,465,467,470,475
460 PRINT"10 SILVER SPOONS":P = 10:RETURN
461 PRINT"A JEWELED SWORD":P = 30:RETURN
463 PRINT"A JAR OF RUBIES":P = 50:RETURN
465 PRINT"A TREASURE CHEST":P = 200:RETURN
467 PRINT"50 SILVER COINS":P = 50:RETURN
470 PRINT"100 GOLD PIECES":P = 100:RETURN
475 PRINT"A BOX OF JEWELS":P = 75:RETURN
490 PRINT"YOU BEAT THE MONSTER"
493 S = S + 1
495 Q = Q + P
497 IFP = 30THENGOSUB800
500 IFP = 200THENGOSUB850:GOSUB867
505 PRINT"YOU NOW HAVE "Q" TREASURE POINTS"
510 A = X:B = Y:INPUT"WHAT DIRECTION (HIT 1 FOR THE
    MAP)";X$
511 IFX$ = "1"THENGOSUB900:GOTO510
512 IFRIGHT$(X$,1) = "W"THENX = X - 1
513 IFRIGHT$(X$,1) = "E"THENX = X + 1
514 IFLEFT$(X$,1) = "N"THENY = Y - 1
515 IFLEFT$(X$,1) = "S"THENY = Y + 1
517 IFA(X,Y) = 0THEN1000
520 IFA(X,Y) = 2THENPRINT"YOU RAN INTO A WALL":
    X = A:Y = B:GOTO510
525 A(A,B) = 1:A(X,Y) = 5:GOTO20
600 PRINT"YOU ONLY HAVE";:RETURN
635 INPUT"HOW MUCH DO YOU WISH TO PAY";K
640 IFK > QTHENGOSUB600:PRINTQ"TREASURE POINTS":
    GOTO635
645 I = INT(RND(1)*22):L = 0:IFI = 21ORK < 1THEN325
660 FORH = 0TO20:IFK < = L*PANDI > = HTHEN680
670 L = L + .1:NEXT
675 PRINT"YOUR BRIBE WAS ACCEPTED.";:
    Q = Q - K:GOTO505
680 PRINT"YOUR BRIBE WAS NOT ACCEPTED.";
685 PRINT"YOU MUST FIGHT":GOTO300
700 PRINT"A GIANT BAT CARRIED YOU TO A NEW SPOT":
    A = X:B = Y
705 X = INT(RND(1)*7 + 2):Y = INT(RND(1)*7 + 2):
    IFA(X,Y) < > 1THEN705
710 A(A,B) = 1:A(X,Y) = 5:RETURN
750 J = INT(RND(1)*20 + 1):C = C - J
755 PRINT"YOU FELL INTO A PIT AND USED"J"COMBAT
    POINTS TO CLIMB OUT"
760 IFC < 0THENPRINT"YOU DIED WHILE CLIMBING OUT":
    GOTO330
765 GOTO375
800 IFRND(1) < .5ORC > 3000THENRETURN
810 PRINT"THE SWORD WAS ENCHANTED AND DOUBLES
    YOUR STRENGTH"
815 C = C*2:RETURN
850 I = INT(RND(1)*10):IFI < > 7THENRETURN
860 PRINT"THE CHEST WAS A TRAP.YOU WERE KILLED
    WHEN YOU OPENED IT"
865 GOTO330
867 I = INT(RND(1)*10):IFI < > 3THENRETURN
870 PRINT"A MIRROR WAS IN THE CHEST.";
875 PRINT"IT WILL KILL ANY BASILISKS YOU MEET":
    N = 1:RETURN
880 PRINT"YOUR MIRROR KILLED THE BASILISK":GOTO493
900 FORI = 0TO10:FORJ = 0TO10:PRINTTAB(5);:
    IFA(J,I) = 0THEN PRINT" ";
901 IFA(J,I) = 1THENPRINT"X";
902 IFA(J,I) = 2THENPRINT"I";
903 IFA(J,I) = 5THENPRINT"0";
905 NEXT:PRINT:NEXT:RETURN
950 IFS < 5THEN400
955 PRINT"A GIANT EAGLE CARRIED YOU TO SAFETY"
1000 PRINT:PRINT"YOU SURVIVED THE FOREST"
1005 PRINT"YOU WON A TREASURE TOTAL OF"Q:
     PRINT"CONGRATULATIONS"
9999 END
```

the amount you think it will take to defeat the monster). Each monster has its own combat strength. If you enter a number of combat points equal to the monster's strength, you have a fifty-fifty chance of defeating it. Entering a higher number increases your chances of winning, while entering a smaller number lowers your chance of winning. No matter how much strength you use, there is always at least a one-in-a-thousand chance that the monster will kill you—not bad odds, unless you have cold feet. Also, the more treasure you have, the more strength you need to use to achieve the same odds against the monster in combat.

If you choose to run (option 2), your chances of getting away from a monster successively decrease as each new monster's strength possibly increases. Thus you are more likely to get away from a minotaur than from a basilisk. If you succeed in running away, you are placed in a new randomly selected square; not getting away usually results in a battle. Occasionally, while you are running, the monster will catch and kill you—one of the risks you must accept.

Of course trying to bribe (option 3) your foe is an age-old alternative to running or fighting. For this, you must use your hard-earned treasure. Whether or not you win depends on the value of the treasure he is guarding. The greater the treasure, the more you have to pay to successfully bribe the monster. If he doesn't care for your bribe, you usually have to fight him.

There are other things in the forest besides monsters, but these are best left for the player to discover. One thing that I will mention is the mirror you may find. This kills basilisks, the most fearsome of all the creatures you will meet. A basilisk can kill people by looking them in the face, but when it looks into a mirror it frightens itself to death.

Movement through the forest is easy: just enter the direction you want to go—N for *north,* E for *east,* NE for *northeast,* and so on. *North* is the top of the map and *east* is the right. The Xs mark out the forest in the display, the *I*s are walls through which you cannot pass, and the *0* is you. To leave the forest, just move onto any blank area around the edge of forest.

Scores for this game generally range from 500 to 700. If you get over 1000, you are doing very well. A sample listing of the game at its end is given in listing 2.

Experience has shown me that this game becomes more exciting as the map gets larger. If you have more than 4 K bytes of memory in your system, you can increase the map size by changing the proper lines in the program (mainly lines 10, 15, 705, and 900). You can also add more monsters and treasure or add other options to the game.

Table 1 lists the monsters and their combat strengths; table 2 lists the treasures and their values. So load up, enter the forest, and hunt! ■

Monster	Combat Strength
minotaur	10
cyclops	20
zombie	30
giant	40
harpy	50
griffin	60
chimera	70
dragon	80
wyvern	90
basilisk	100

Table 1: *A list of monsters that can be found in the forest and their combat strengths.*

Treasure	Value
ten silver spoons	10
a jeweled sword	30
a jar of rubies	50
fifty silver coins	50
a box of jewels	75
100 gold pieces	100
a treasure chest	200

Table 2: *A list of treasures and their values.*

Listing 2: *Part of a sample run of* Monster Combat *program. Each* X *represents part of the forest, each* I *represents part of a wall that must be circumnavigated, and the single* 0 *represents the player.*

```
X X I X I X X X X
X X X X X I I X I
I I I X X X X X X
X X I X I X X I X
I X I I X X X X X
X 0 I X X X X X X
X X X X X X X X X
I X X I X X X X X
X I X X I I X X X

YOUR COMBAT STRENGTH IS 1270
A CHIMERA IS GUARDING 50 SILVER COINS
DO YOU (1)FIGHT,(2)RUN, OR (3)BRIBE? 2
YOU MUST FIGHT
HOW MANY COMBAT POINTS DO YOU WISH TO USE? 132
YOU BEAT THE MONSTER
YOU NOW HAVE 80 TREASURE POINTS
WHAT DIRECTION (HIT 1 FOR THE MAP)? SW

X X I X I X X X X
X X X X X I I X I
I I I X X X X X X
X X I X I X X I X
I X I I X X X X X
X X I X X X X X X
0 X X X X X X X X
I X X I X X X X X
X I X X I I X X X

YOUR COMBAT STRENGTH IS 1138
A DRAGON IS GUARDING 10 SILVER SPOONS
DO YOU (1)FIGHT,(2)RUN, OR (3)BRIBE? 3
HOW MUCH DO YOU WISH TO PAY? 10
YOUR BRIBE WAS ACCEPTED.YOU NOW HAVE
  70 TREASURE POINTS
WHAT DIRECTION (HIT 1 FOR THE MAP)? W

YOU SURVIVED THE FOREST
YOU WON A TREASURE TOTAL OF 70
CONGRATULATIONS
```

Editorial continued from page 12

Speed Press, 1979. As Alvin Toffler says, "The shortest distance between two facts may well be Alden Todd." Even practiced denizens of the library will find information of interest in this book about reference sources.

Sloane, William. The Craft of Writing. *New York: Norton, 1979.*

Some Examples of Good Technical Writing

Knuth, Donald E. The Art of Computer Programming *(three volumes). Reading MA: Addison-Wesley, 1968, 1969, 1973. An indispensable set.*

Papert, Seymour. Mindstorms: Children, Computers, and Powerful Ideas. *New York: Basic Books, 1980. A refreshingly readable text that discusses Piaget's theories about learning and the use of personal computers in the classroom.*

Gardner, Martin. The Ambidextrous Universe, *second edition. New York: Scribner's, 1979. This book deals with symmetry in nature, and shows Gardner's remarkable ability to discuss technical subjects in the clearest of terms. He is the author of the monthly "Mathematical Games" column in the* Scientific American *magazine. I recommend all of his books to those interested in good technical writing.*

Hofstadter, Douglas R. Gödel, Escher, Bach: An Eternal Golden Braid. *New York: Basic Books, 1979. This Pulitzer prize-winning work discusses computer science, art, music, philosophy, and physics in a way that is nothing short of wondrous. It is positive proof that a technical book can be artistic, rigorous, and fascinating.*

Swann and Johnson, Prof. E. McSquared's Original, Fantastic, and Highly Edifying Calculus Primer, Joint Edition. *Los Altos CA: William Kaufmann, Inc, 1975. This colorful offbeat book is actually a cleverly disguised introduction to differential calculus in comic book form. It manages to be witty and rigorous at the same time. Would that there were more books like this one.*

Jacobs, Harold, Mathematics: A Human Endeavor, and Geometry. *San Francisco: W S Freeman and Co., 1976, 1978. The art of the textbook at its finest.*

Two other writers should be mentioned for their contributions to good technical writing: Jeremy Bernstein and Philip Morrison. Their book reviews about scientific and mathematical books appear regularly in the New Yorker *and the* Scientific American, *respectively, and they are among the best in their field.* ■

Articles Policy

BYTE is continually seeking quality manuscripts written by individuals who are applying personal computer systems, designing such systems, or who have knowledge which will prove useful to our readers. For a more formal description of procedures and requirements, potential authors should send a large (9 by 12 inch, 30.5 by 22.8 cm), self-addressed envelope, with 28 cents US postage affixed, to BYTE Author's Guide, 70 Main St, Peterborough NH 03458.

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BYTE's Bugs

A Strategic Bug

The program in the article by John Rheinstein "Fifteen: A Game of Strategy (or Tic-Tac-Toe Revisited)" (June 1980 BYTE, page 230) contains an error in line 720. Instead of:

"720 IF T2 > 0 THEN 270"

the line should read:

"720 IF T2 > 0 THEN 750"

If the program is input as given, you get nothing but a sequence of prompts that say "YOUR MOVE?"

An alternate fix is to delete line 460 and lines 650 thru 810. The program then runs satisfactorily, but does not recognize a tie game after only 8 moves (which is possible as the user always

moves first), and does not recognize a tie game at all if the program is modified to let the machine move first.

Mr Rheinstein has provided an interesting twist on the old game of tic-tac-toe. I've played several dozen games and haven't won yet, but I'm still trying!

Clinton R Foulk
5101 Delancey St
Columbus OH 43220

Error in Airborne Navigation

A typographical error occurred in the "Desk Top Wonders" item "Calculator Airborne Navigation: The HP-25 Finds Ground Speed and True Heading," by L J Kuhns (November 1979 BYTE, pages 245 and 246).

In the program listing on page 246, six consistent substitutions of "8" for "g" were made; for instance, in line 09, "8≥0" should have been "g≥0". The errors were in lines 9, 14, 25, 30, 33, and 44. The use of "g" refers to an operation involving the blue function-entry key.

We at BYTE hope that no one has navigated incorrectly due to this error.

Benchmarking Errors

We cannot seem to get benchmark programs right. There is an error in listing 1 of the Technical Forum article "Some More Notes on Performance Evaluation," by Carl Helmers, in the July 1980 BYTE (pages 216 thru 219). (The article itself contains a correction for a previous BYTE article on benchmarking.)

```
110 IF A(I)=0
THEN 100 ELSE 90
```

should read:

```
110 IF A(X)=0
THEN 100 ELSE 90
```

Our thanks go to Tom Kelly Jr of Salem, Ohio, and other readers for pointing this out to us.

In addition, our staff found that the program has no way to print out the results by executing lines 120 thru 170. To correct this, change line 110 to:

```
110 IF A(X)=0
THEN 100 ELSE 85
```

and add line 85:

```
85 IF 2*X>L THEN 120
```

We apologize for these errors.

Sorry, Wrong Number

The October 1980 issue of BYTE contains an error on page 347, in the "What's New?" column. The telephone number listed for Moore Business Forms Inc, is incorrect. The numbers are (800) 942-8330 in Indiana, and (800) 323-8326 for the rest of the US.■

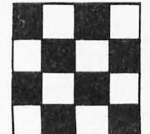
BYTE's Bits

National Computer Conference 1981 Needs Panelists

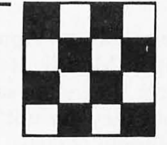
Interest has been steadily mounting for a panel discussion on personal robotics and artificial intelligence ideas, applications, and accomplishments. And now, the Personal Computing Festival of the National Computer Conference 1981 will offer this opportunity. If you wish to participate in this discussion, send a description of your interest area and the contents of a 5-minute presentation to A Gelles, 185 W Houston St, New York NY 10014. Participants should be nonprofessionals in robotics and artificial intelligence disciplines.

The conference will be held in Chicago, Illinois, on May 5 thru 7, 1981. Additional information may be obtained by writing to the above address.■

Circle 216 on inquiry card.



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by David Kittinger

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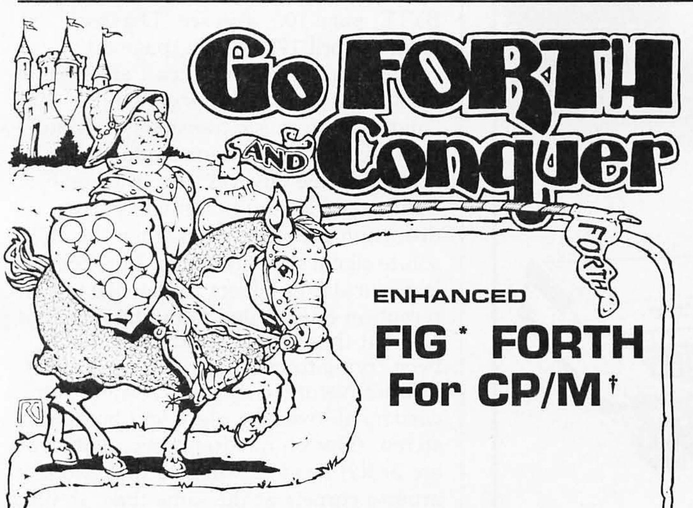
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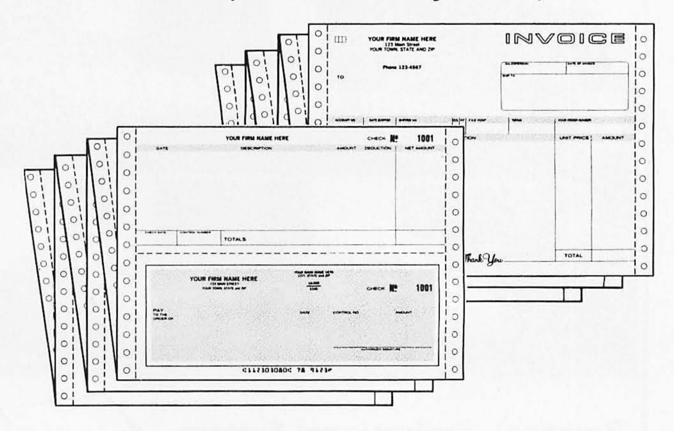
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Letters continued from page 20:
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Norman McEntire
323 Tram Rd
Columbia SC 29210

Beware Automatic Color TVs

BYTE readers should be made aware that RF (radio-frequency) modulators such as the popular Sup'R' Mod II manufactured by M & R Enterprises may not be compatible with certain television sets. Unhappily, I discovered this fact when I purchased a new RCA color television equipped with all-electronic tuning for use with an Apple II equipped with a Sup'R' Mod II. It seems that the electronic tuners are so stable and accurate that they are not required to have a fine-tuning control. Unfortunately, the UHF (ultra-high frequency) oscillator in a typical radio-frequency modulator is anything but stable and accurate. To "find" the signal put out by the radio-frequency modulator, either a fine-tuning control on the television or a frequency-adjustment control on the radio-frequency modulator is an absolute necessity. Having neither in my case (the Sup'R' Mod II has no frequency adjustment), I am out of luck.

It may be that radio-frequency modulators operating on VHF (very-high frequency) channels 3 or 4 may be more accurate. But in any event, BYTE readers should be aware of this potential problem if they are in the market for a color television for use as a monitor, or for a radio-frequency modulator to use with the new breed of television sets lacking fine-tuning controls.

Jacob Z Schanker, PE
105 Colony Ln
Rochester NY 14623

In a related situation, I cannot play back prerecorded videotapes on my 1978 color television. Commercial tapes add an antipiracy signal that causes the picture to roll. This can be remedied by adjusting the vertical hold on your television—unless you have an automatic color television (like mine) that doesn't have such a control anywhere . . . GW

Fidelity versus Digicast (or Datacast)

Although I missed the article on the Digicast Project in the January 1979 BYTE (our BYTE magazine goes through a lot of hands), I would like to comment on Noel Moss's letter in the April issue. (See "The Digicast System: Receiving Data and Information Over Your FM Radio," by A I Halsema, January 1979 BYTE, page 100; also see "Digicast Data," April 1979 BYTE, page 8.)

As a former FM broadcast engineer, I disagree with Mr Moss's contention that "high-fidelity music transmission is not restricted by the current modulation limits." In the lab, yes, but in these Tennessee hills multipath will create distortion problems even when the absolute signal strength is just fine. Stereo in particular is subject to damage in reception quality due to multipath.

What those music syndicators have been trying to tell us is: you can't cheat Mother Nature. Sure, you can put subcarriers all over the place and broadcast stereo. (Dorren quadraphonic, while you are at it?) But you can't do that and see around corners at the same time. In hilly terrain or metropolitan areas, it is best to limit your bandwidth as much as possible, or suffer the high cost of listener dissatisfaction with your mobile reception.

SCA (subsidiary communications authorization) for digital data is a special problem. For some time we at station WSMC attempted to use our subcarrier to route telemetry from the transmitter to the studio's remote control. Please bear in mind that the data rate of this is about 2 bps (bits per second). The result was a very noticeable flutter sound in receivers that did not have a line of sight to our antenna, which was modulated by mountain peaks in mobile reception.

Circle 220 on inquiry card.

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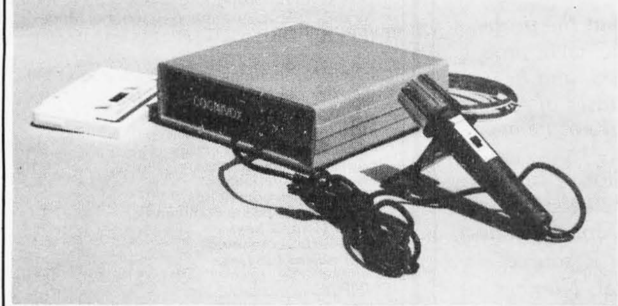
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Circle 222 on inquiry card.

The result was a decision against SCA and against switching-type stereo encoders—this latter decision was made because we would rather have any problems in the stereo signal result in placement errors in the stereo field instead of adding to distortion.

The best place for digital broadcasting, in my view, is in the blanking intervals in television video signals. This is being used with great success in public television for subtitling for the hearing-impaired. Please don't crowd our marginal FM signals with it!

John Beckett
Director of Computer Services
Southern Missionary College
Collegedale TN 37315

The Digicast Project has been renamed the "Datacast Project" by its principal proponent, Jim Warren. No regular Datacast service is now in operation, but in a recent telephone conversation, Mr Warren told me, "The only thing that's holding up Datacast is Jim Warren." He added that several tests have been performed both in Sacramento, California, and in the San Francisco Bay area, and that he intends to pursue Datacast when some other projects are completed.

I also talked with Harry R Anderson, the broadcast engineer who helped perform the tests. He agrees with many of the points made by Mr Moss (noting that few people can detect a 1 dB difference in volume), but derogates the objections of Mr Beckett regarding increased multipath distortion resulting from use of the SCA.

Mr Anderson believes that the problems experienced by WSMC were probably caused by other factors, and he says that the theoretical causes of multipath distortion should not be affected by SCA subcarriers.

Mr Anderson is the author of two articles on the Digicast/Datacast system. See "Digicast: Towards a More Effective Use of the Radio Spectrum Resource," Intelligent Machines Journal, *Number 10, June 25, 1979, page 18; also see "Digicast: A Status Report,"* Intelligent Machines Journal, *Number 17, October 31, 1979, page 10. . . .* **RSS**

The End of the CBT

The article by Ron Parsons about a 6860-based modem was excellent. (See "An Answer/Originate Modem," June 1980 BYTE, page 24; also see the "BYTE's Bits" item "Tracking Down the Modem Filters," September 1980 BYTE, page 312.)

Unfortunately, on January 1, 1980, the Bell Telephone system made the CBT data-access arrangement (DAA) obsolete. No telephone-line interface

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```
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      |First one            |Second one           |Third one
 8:00 |John Smith/root canal|---------------------|--------------------|
  :10 |.....................|                     |Ed Jones/check up and|
  :20 |.....................|                     |x-rays..............|
  :30 |.....................|Dennis Johnson/wisdom|....................|
  :40 |.....................|tooth extraction.....|....................|
  :50 |.....................|.....................|                    |
 9:00 |---------------------|.....................|--------------------|
  :10 |Kathy Nelson/check up|.....................|                    |
  :20 |.....................|.....................|                    |
  :30 |                     |.....................|Judith Washington/..|
  :40 |                     |.....................|restoration.........|
  :50 |Mike Silva/restoration|                    |....................|
10:00 |.....................|---------------------|....................|
  :10 |George Kennedy/::::::|                     |                    |
  :20 |restoration::::::::::|                     |                    |
  :30 |.....................|Thelma Carter/check up|                   |
  :40 |.....................|.....................|                    |
  :50 |                     |                     |                    |
11:00 |---------------------|---------------------|--------------------|
S(chedule C(ancel  M(odify  L(ook for openings  H(old in  R(eschedule list
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devices can be obtained through the telephone company. With this act, the telephone company made obsolete an entire generation of equipment, including modems and telephone-answering devices.

At present, I can find no one who is providing CBT couplers or devices equivalent in function for sale, although the telephone company insists that these are available through "electronics supply houses."

The current regulations specify that any device to be directly connected to the telephone lines must be certified as compatible by the FCC (Federal Communications Commission). This is beyond the means of most individuals. About the only legal means left is to purchase one of the commercially available direct-connect modems or settle for an acoustically coupled unit.

James R Boatright
3112 W 11th
Topeka KS 66604

Comments on the August Issue

Editor's Note: *BYTE readers were even more vocal than usual this month about our August 1980 FORTH language issue. Apparently, the combination of Steve Ciarcia's article ("A Build-It-Yourself Modem for Under $50"), the many FORTH articles, and the article by Theron Wierenga on "Construction of a Fourth-Generation Video Terminal" (no pun intended) combined to hit a collective nerve. Here are some of the short, usually anonymous reader comments we received on the monthly BOMB cards (for an explanation of the BOMB card, see the back of this issue).*

Incidentally, wildly enthusiastic comments about FORTH outnumbered negative comments by a factor of 10 to 1:

- More FORTH!! Pascal's just another language to eliminate programmers, but FORTH is a language *for* programmers (and engineers and scientists and businessmen and kids and everybody)!
- I would like to see more articles on FORTH—best single issue since Volume 1, Number 1.
- Excellent coverage. I believe FORTH is a language worth learning and using. My TRS-80 will be running MMSFORTH as soon as possible!
- Economically, FORTH has got to be a major breakthrough. Memory doesn't come cheap and you don't need much of it!
- FORTH is fantastic. It's like heroin . . . you gotta have more once you try it. How about some more in the near future?
- I was quite impressed by FORTH and

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because of #4 [John James's "What is FORTH? A Tutorial Introduction"] I am getting TFORTH for the TRS-80.

- The simplicity of FORTH is an ideal showcase for modularity and extensibility. #3 [Charles Moore's "The Evolution of FORTH, An Unusual Language"] was entertaining and human. The diagrams and charts of #4-6 [three other FORTH articles] were wonderfully simple, direct, and to the point.
- Best overall issue in a long time. I have already ordered a FORTH compiler for my 16 K Apple II.
- Let's have all you can get on how to implement and how to use threaded languages.

The few negative comments we got were also strongly stated:

- Easily the worst issue ever.
- Yeech! This issue soured on the way!
- Too much emphasis on FORTH. I like to see a variety each month (maybe spread it out). (Had the emphasis been nearer my interests, would have loved it. You can't please all the people . . .)

Other languages were also mentioned as topics for future articles (future BYTE authors, take note):

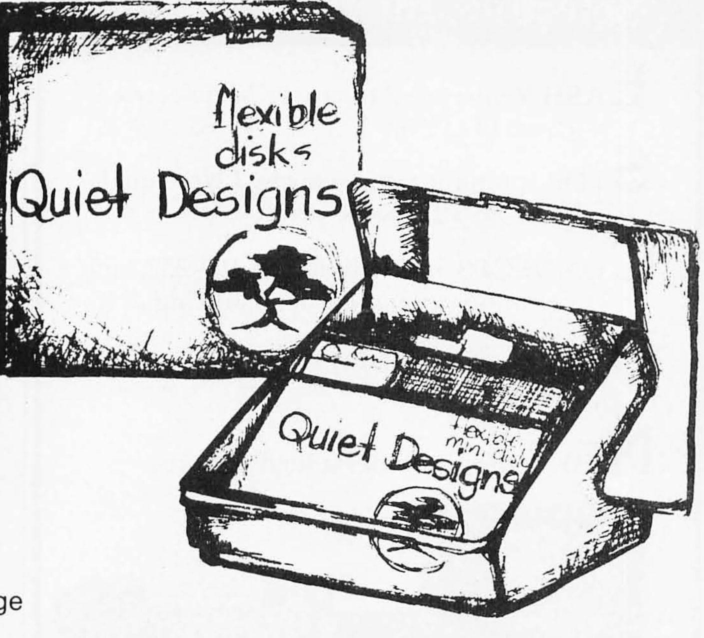
- Loved it!! More FORTH, APL, LISP, and other wild and crazy languages.
- I hope that at some time in the near future, an issue will be devoted to C.
- SNOBOL *NOW*!
- How about some programs in the Apple Pascal system assembler?
- For next year's language issue, please consider one that directly supports concurrency—Concurrent Pascal, Ada, etc.

Other comments included general enthusiasm for the issue and a good deal of respect for the article on Khachiyan's algorithm ["Khachiyan's Algorithm, Part 1: A New Solution to Linear Programming Problems"]:

- More Steve Ciarcia!
- Superb issue! Hope there is another volume of *Ciarcia's Circuit Cellar* and a *BYTE Book of FORTH* to be made available for the Christmas season!
- Still have not figured out the math in #7 ["Khachiyan's Algorithm, Part 1"] but a little bit (lot?) of work won't hurt me. Give us more on FORTH. Best issue to date.
- More hardcore math like the Khachiyan algorithm.
- The editorial ["Threads of a FORTH Tapestry"] gets an 8!
- The Khachiyan algorithm piece appeals to a very narrow readership and is quite advanced—as noted. However, we all need something to tease us into advancement once in a while! ■

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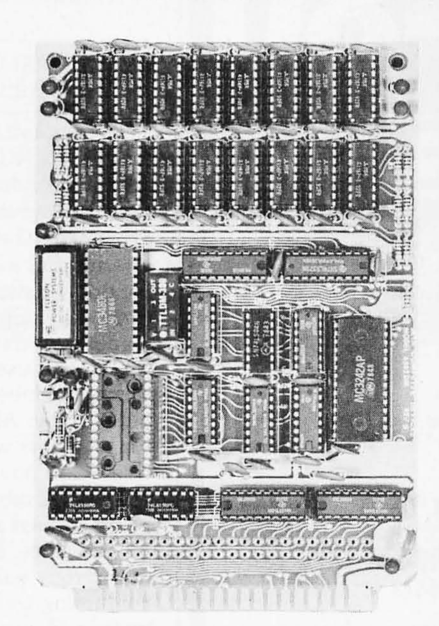
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Clubs and Newsletters

Heathkit Group in San Diego

The San Diego Heathkit Computer Users Group has been formed to help users on the local level. The club meets on the first Wednesday of each month at the La Mesa Heathkit Store at 7 PM. Membership is $10 per year. The club wishes to exchange newsletters and ideas with other clubs. Contact R A Cobb, 12202 Kingsford Ct, El Cajon CA 92021, (714) 443-4772.

Microcomputer Users International

Microcomputers Users International is a group serving the Sault Ste Marie area. The group publishes a monthly newsletter entitled *Northern Bytes*. The newsletter is available to other groups on an exchange basis. Meetings are held on the third Tuesday of each month. Contact Jack Decker, 1804 W 18th St, Lot #155, Sault Ste Marie MI 49783, (906) 632-3248. In Sault, Ontario, phone (705) 942-1363, and ask for Phil Barton or Frank Gardner.

National Computer Association (NCA)

The organizational structure of the NCA, an independent nonprofit computer user group, has been expanded. The NCA is now offering full membership to vendors, consultants, OEMs (original equipment manufacturers), manufacturers, end users, and affiliated membership to computer clubs. Also, subgroups for members with similar interests are now being offered. The subgroups are being formed along product-interest lines. Monthly newsletters will be published containing technical information. A new subgroup must have a potential of 200 members. Membership within NCA is $35, which includes membership within a subgroup. Computer club affiliation entitles the club to receive all NCA publications. Clubs may join for an annual fee of $50. Club members can join as individual members, if so desired. Contact NCA, 1485 E Fremont Cr S, Littleton CO 80122, (303) 797-3559.

PIE for PET Users

PIE (PET Information Exchange) is made up of PET/CBM users. Meetings are informal and they are held approximately twice every month at various locations in Rhode Island. A newsletter is published. The dues are $6 per year. The group is involved in a project to install two BASF floppy-disk drives behind the name-plate on a new 32 K-byte PET. Other future projects include a computer bulletin board service for the group members. Contact PIE, 27 Leicester Way, Pawtucket RI 02860.

Salem Area Computer Club

The Salem Area Computer Club (SACC) membership is open to anyone interested in using microcomputers. Membership dues are $5 per year, which includes the monthly newsletter. Meetings are held on the first Monday of each odd-numbered month at the McKinley Community School, 461 McGilchrist St SE, in Salem, Oregon. On the first Monday of even-numbered months, meetings are held at Computer Pathways Unlimited, 831 Lancaster Dr NE, South End—Lancaster Mall, Salem, Oregon. Contact SACC, c/o Doug Walker, 3485 Mock Orange Ct S, Salem OR 97302, (503) 364-2488.

Small Computer News

Small Computer News is a biweekly newsletter covering the microcomputer field. Written for the computer hobbyist, manufacturer, and retailer, each issue contains information on the microcomputer business, new product previews, convention news, and free-lance and career employment opportunities. Subscriptions, including first class postage, are available for $24.50 per year from Edwards Publications, 78-56 86th St, Flushing NY 11385, (212) 441-4082.

Electronic Magazine for DEC Users

Digital Digest is a digital magazine that operates 24 hours a day. To utilize this information exchange, users need a 300 bps (bits per second) modem and terminal set up for seven data bits, even parity, and one stop bit. The initial data line number is (404) 447-5254. The magazine is directed at the DEC (Digital Equipment Corporation) PDP-11 user and will be expanded to handle Data General users. Featured in the magazine will be a free PDP-11 software exchange, DEC users buying group co-op, electronic mail box, software and hardware product index, and more. The electronic version of *Digital Digest* is free and the printed version is $15 per year. The Digital Exchange software exchange system is free for contributing members and $75 for noncontributors. Contact Digital Publications Inc, 1101 Noble Forest Dr, Norcross GA 30092.

OSI-MUG

OSI-MUG (Ohio Scientific Michigan Users Group) has recently been formed. The club has over 130 members, primarily from the southeastern Michigan area. The members are interested in exchanging information with similar groups. Contact OSI-MUG, 3247 Lakewood Ave, Ann Arbor MI (313) 761-5358.

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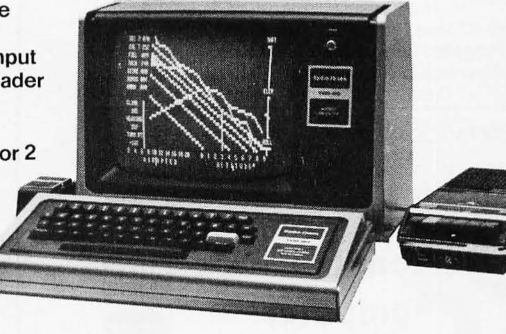
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INAUG

INAUG (International Apple Users Group) is dedicated to increasing the flow of information between Apple users worldwide. The INAUG requests that all Apple users and groups unite and join its group. Please send a self-addressed, stamped envelope for more information. The address is INAUG, POB 96, Twain CA 95984, (916) 283-3497.

Another Apple Group

The OKC Apple Users Group meets at various computer stores in the Oklahoma City area on the first and third Tuesday of each month. Its newsletter is entitled *OKC Apple Times*. Membership dues are $10 per year, which includes a subscription to the newsletter. OKC is a member of the International Apple Corps. Contact The Secretary, OKC Apple, c/o Greenbriar Digital Resources, POB 1857, Edmond OK 73034.

UK TRS-80 Users Group

This United Kingdom-based group currently has over 230 members, and along with publication of their monthly newsletter, they organize single-day and weekend workshops in different parts of the country. A software library is available for members' use. Membership is by subscription to the newsletter, which is £5.75. Contact Brian Pain, 40a High St, Stony Stratford, Milton Keynes, England.

The Portland Computer Society

This group has over 180 members and a busy schedule of meetings. The main meeting is held on the third Saturday of each month at the Far West Federal Savings, Fred Meyer Raleigh Hills Shopping Center, 4770 SW 76th (Beaverton Hillsdale Hwy). They have many other special interest groups that meet regularly. A news-

letter is published monthly that contains items about the meetings of special groups, industry items, letters from members, and other news. Contact PCS, POB 17371, Portland OR 97217.

Computerized Bulletin Board Service in Milwaukee

MAUDE (Milwaukee Area Utility for Digital Exchanges) is a computerized bulletin board in Milwaukee, Wisconsin. MAUDE is available to anyone who has access to a terminal or terminal emulator equipped with a standard modem. The system allows the posting and retrieval of messages of interest to computer hobbyists. There is no charge for using MAUDE. The number for MAUDE is (414) 241-8364. For more information, contact John Taylor, POB 121, Hartland WI 53029.

Prince William Computer Club

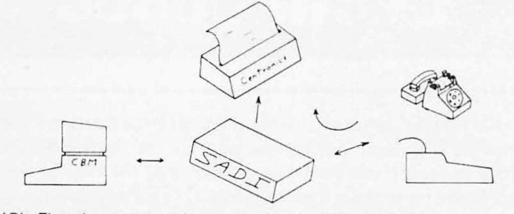
The Prince William Computer Club holds its regular meetings at the Prince William Branch Library, Woodbridge, Virginia, on the first Tuesday of each month at 7:30 PM. For information, call Don Bennett, (703) 670-4773.

The Red Sea Apple Club

The Red Sea Apple Club is located in Saudi Arabia. Most members have Apple II computers with two disks and the Pascal system. They are interested in corresponding with any and all clubs and individuals so that they can keep up with the current trends in the American microcomputer world. The group is also interested in swapping disks. The club's address is Red Sea Apple Club, c/o Saudi Arabian Parsons Ltd, POB 3694, Jeddah, Saudi Arabia. ■

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December 1980

December 9-12 and 15-17

Training Courses for Engineers, Fairchild's Microcomputer Education Center, San Jose CA. This series of technical training courses are offered for design engineers who must learn to design the microprocessor into a working system. The curriculum includes courses on data communications and the 6856 device, 3870 microcomputer designs, the 6800 microprocessor, and bit-slice techniques. Contact the Center at MS42-2120, 101 Bernal Rd, San Jose CA 95119, (408) 224-7095.

December 10

1980 Computer Networking Symposium, Gaithersburg MD. The symposium is sponsored by the IEEE Computer Society, Technical Committee on Computer Communications, and the Institute for Computer Sciences and Technology of the National Bureau of Standards. The focus is on office automation, office system components, and the computer networks required to interconnect them. For information, contact Executive Secretary, POB 639, Silver Spring MD 20901, (301) 439-7007.

January 1981

January 7-9

The Fourteenth International Symposium on Minicomputers and Microcomputers, Hotel del Coronado, San Diego CA. The scope of the symposium will cover technology, hardware, software, engineering, languages, systems architecture, operating systems, numerical methods, computer networks, and other aspects of computing. Contact the Secretary, MIMI '81 San Diego, POB 2481, Anaheim CA 92804.

January 7-10

The Fourteenth Annual Hawaii International Conference on System Sciences (HICSS), Ilikai Hotel, Honolulu, HI. HICSS is designed to bring together the academician and practitioner in a forum for the interchange of ideas in all areas of information systems technology. Seminars and discussions will cover computer hardware, software, medical information processing, and computer-based decison support systems. Contact HICSS-14, c/o Office of Management Programs, University of Hawaii, 2404 Maile Way C-202, Honolulu HI 96822

January 8-11

Winter CES, Las Vegas Hilton, Convention Center, and the Jockey Club Hotel, Las Vegas NV. Over 700 manufacturers will be exhibiting goods from the audio, video, personal electronics and microcomputer industries. Contact The Consumer Electronics Shows, 2 Illinois Center, Suite 1607, 233 N Michigan Blvd, Chicago IL 60601, (312) 861-1040.

January 13-15

Communications Networks 1981, Albert Thomas Con-

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vention Center, Houston TX. This show will feature exhibits and seminars covering network policy and management for US and international users and carriers; network architecture, software, and hardware; new developments; information appliances; and more. This conference is aimed at communications professionals and carriers, service and hardware vendors who are interested in combining voice, data, and message systems applications. Contact Communications Networks '81, c/o The Conference Company, 60 Austin St, Newton MA 02160, (617) 964-4550.

January 14-19

The Forty-Second National Audio-Visual Convention and Exhibit, Dallas Convention Center, Dallas TX. Over 300 manufacturers and producers of audio-visual, video and microcomputer hardware and software will be exhibiting their products. Seminars will cover marketing and production of audio-visual items. For more information, contact the National Audio-Visual Association, 3150 Spring St, Fairfax VA 22031, (703) 273-7200.

January 16-17

Microcomputer Conference, Arizona State University, Tempe AZ. The goal of this microcomputer conference is to introduce educators to the applications of computers in the classroom. The emphasis of the conference is to provide an awareness of microcomputers and their impact on society. For further information, contact Dr Gary G Bitter, Arizona State University, Payne 203, Tempe AZ 85281.

January 27-29

Advanced Semiconductor Equipment Exposition, San Jose Convention Center, San Jose CA. Over 100 exhibitors will feature equipment at this trade show. The show's emphasis is on new products and emerging technology in the semiconductor processing and production fields. Contact Cartlidge & Associates, 491 Macara Ave, Suite 1014, Sunnyvale CA 94086, (408) 245-6870.

January 28-31

The Third IMMM/Data Comm International Japan Expositon, Harumi Expositon Center, South Hall, Tokyo, Japan. Over 15,000 scientists, design engineers, technical managers, applications engineers, and other specialists are expected to attend this show. Internepcon Japan/Semiconductor International is held concurrently. The conference program will include talks on microcomputer-controlled data communications systems, peripheral interfacing, software management, and more. Contact Industrial and Scientific Conference Management Inc, 222 W Adams St, Chicago IL 60606, (312) 263-4866.

February 1981

February 2-5

The Second Middle East Electronic Communications Show and Conference, Bahrain Exhibition Centre, Bahrain. This conference will cover communications research, technology, and administration in satellite communications, digital communications, networks and industrial systems, and business communications. An exhibition will also be held. Contact TMAC, 680 Beach St, Suite 428, San Francisco CA 94109, (800) 227-3477.

February 4-5

Computer and Office Automation Show and Conference, Hyatt Regency Hotel, Vancouver, Canada. This conference will feature data-processing equipment, small-business computers, computer peripheral products, medium and high-speed copiers, word-processing systems, and conventional office products and services. Seminars on the role of computers in information management, electronic mail, data base applications, and other related topics, will be given. Contact Whitsed Publishing Ltd, Suite 1201, 55 Bloor St W, Toronto, Ontario, Canada M4W 3K2.

February 9-13

Reliability Engineering, Testing and Maintainability Engineering, University of California at Los Angeles. This course is designed for reliability, product assurance, logistics, quality assurance, and design engineers. The course is intended for those required to design and to predict the reliability of components, equipment, and systems. The fee is $750. Contact Continuing Education in Engineering and Mathematics, UCLA Extension, POB 24901, Los Angeles CA 90024, (213) 825-1047. ■

Ask BYTE

Conducted by Steve Ciarcia

Blowing in the Wind

Dear Steve,

I wish to interface a digital anemometer to my Cromemco System III, but I have only a vague idea of the steps involved. I live on a windy hilltop and want to log wind-velocity data (to help me select the best type of windmill for electrical power generation).

The anemometer that I have is a Trade-Wind Model DIG78, manufactured by Trade-Wind Instruments, 1076 Loraine St, Enumclaw, WA 98022. The indoor display unit shows wind speeds from 00 to 99 mph (miles per hour) either instantaneously or by maximum gust encountered. This display uses CD4511 latch/decoder drives. (See figure 1.)

My general idea is to employ some three-state buffer circuits to transfer BCD (binary-coded decimal) data from the anemometer to the computer, then load the data into the accumulator with the IN instruction. What portion of the anemometer electronics should I tie into? What S-100 bus line should I use as a device-select signal?

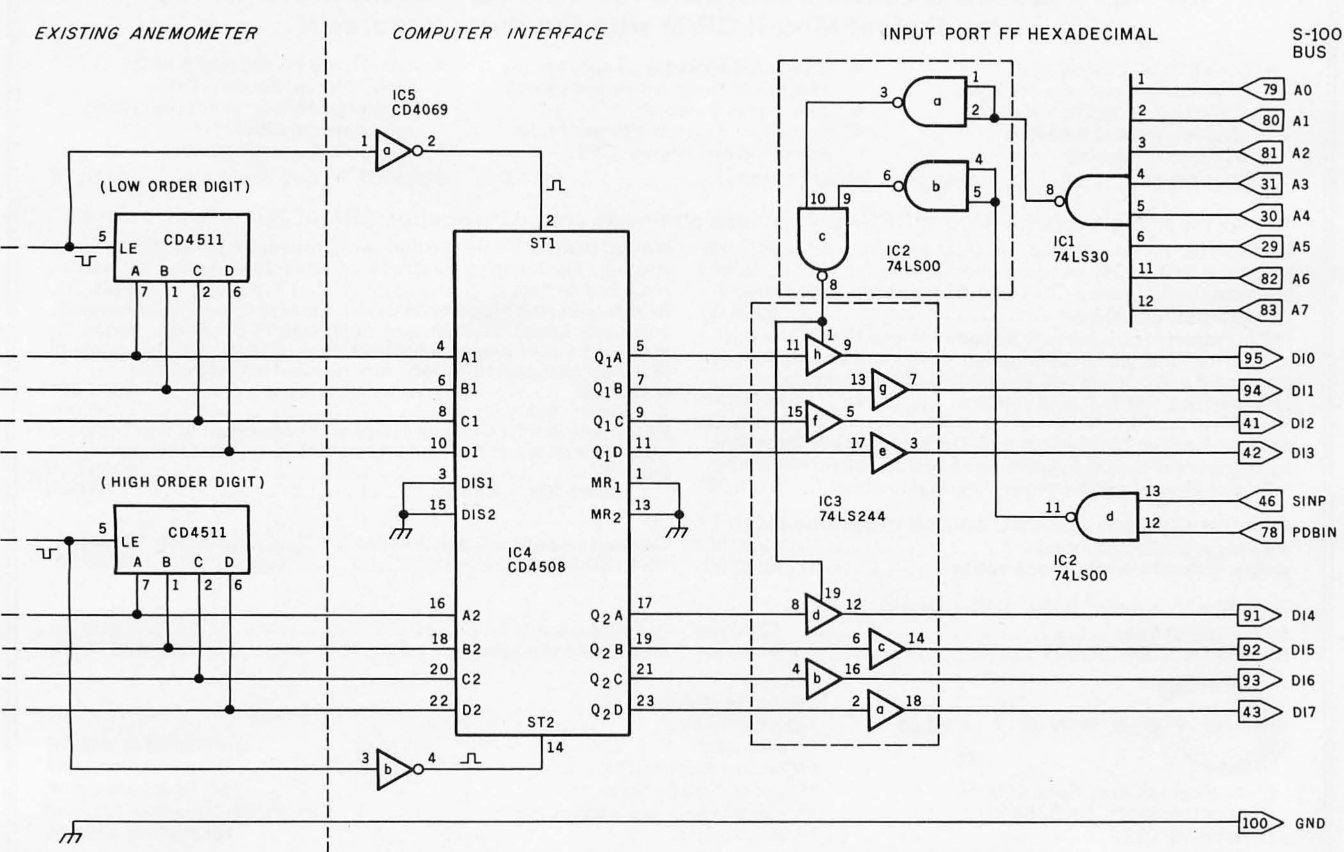
Paul Palaske

Interfacing an anemometer to a computer sounds like something I'd do. Connecting it to an S-100 computer isn't terribly difficult. The accompanying circuit diagram should work, provided Trade-Wind Instruments used the devices you listed in the classical tradition. It is not enough to simply send the BCD signals to the S-100 bus; they must also be latched and gated at the proper time.

First, so that the computer knows what port it is reading, IC1 and IC2 are wired to decode hexadecimal port FF. (If you prefer another address, refer to my "Circuit Cellar" article on parallel ports in the June 1980 BYTE, page 37 "I/O Expansion for the TRS-80, Part 2: Serial Ports".) This signal is used to gate the output of a dual 4-bit latch (IC4) onto the bus. This latch is necessary because there is no way to tell how long the BCD-data signals in the anemometer are valid. It may be only a microsecond or two. When the output digits are updated, they are automatically latched into the IC4 as well. In this way, computer-program execution speed is independent of the electronics in the anemometer. This circuit should provide what you need.... **Steve**

Number	Type	+5V	GND
IC1	74LS30	14	7
IC2	74LS00	14	7
IC3	74LS244	20	10
IC4	CD4508	24	12
IC5	CD4069	14	7

Figure 1



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Interfacing a Joystick

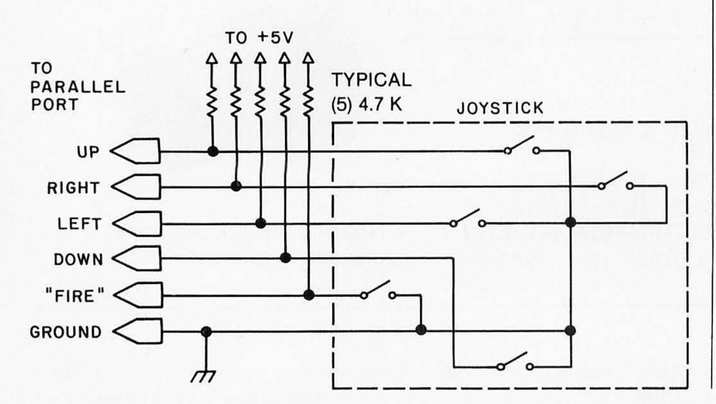
Dear Steve,

I would like to interface an Atari joystick (made up of simple switches, not potentiometers) to the input port of my Exidy Sorcerer microcomputer. I don't believe the software will be difficult, but do I hook up the "common" wire from these switches to +5 V, and each lead to an input bit on the port? Are "tie-up" resistors required?

Richard Legault

Although I am not familiar with the Sorcerer, I assume that the input port is TTL (transistor-transistor logic) or LSTTL (low-power Schottky TTL); if so, I suggest that you attach a pull-up resistor and switch to each bit as shown in the diagram (see figure 2). When the switch is open, a logic 1 is presented to the input port; when the switch is closed, a logic 0 is presented.... **Steve**

Figure 2



Periodical Guide

Dear Steve,

I am currently building a Central Data 2650 computer system, which uses S-100 circuit boards for memory and I/O (input/output). Could you please send me a list of construction articles that have appeared in BYTE and other magazines that might help me?

Kenneth Johnston

It sounds to me as though you need a good periodical guide. I suggest that you order a complete set of the Periodical Guide for Computerists, *E Berg Publications, 14751 112th Ave NE, Kirkland WA 98033.*

The guides start in 1975, and cost between $5 and $6 per year thru 1979. They include both subject and author indexes for over 9800 articles from BYTE, Electronics, Computer Design, Radio Electronics, *and twenty other magazines.*

The guides include listings under such varied topics as construction, languages, and robotics. These guides should help you find what you want.... **Steve**

Quick and Cheap

Dear Steve,

For my high school science fair project, I am interested in building a microcomputer to show the advantages and uses of a microprocessor. I have not been able to find suitable plans, and I think that you can help me.

The unit I would like to construct should be of reasonable cost ($50 or so), show the basic workings of a microprocessor, and still be of some use to me in my home or on my farm. The unit could also incorporate photoelectric or heat-sensor devices. I have failed so far to find anything that fulfills my requirements. Do you know of any plans or kits that are close to what I am describing?

I would very much appreciate it if you could spare some time and do some searching for me. My science fair is about a month away, so I need your advice as soon as possible.

Kevin Meysenburg

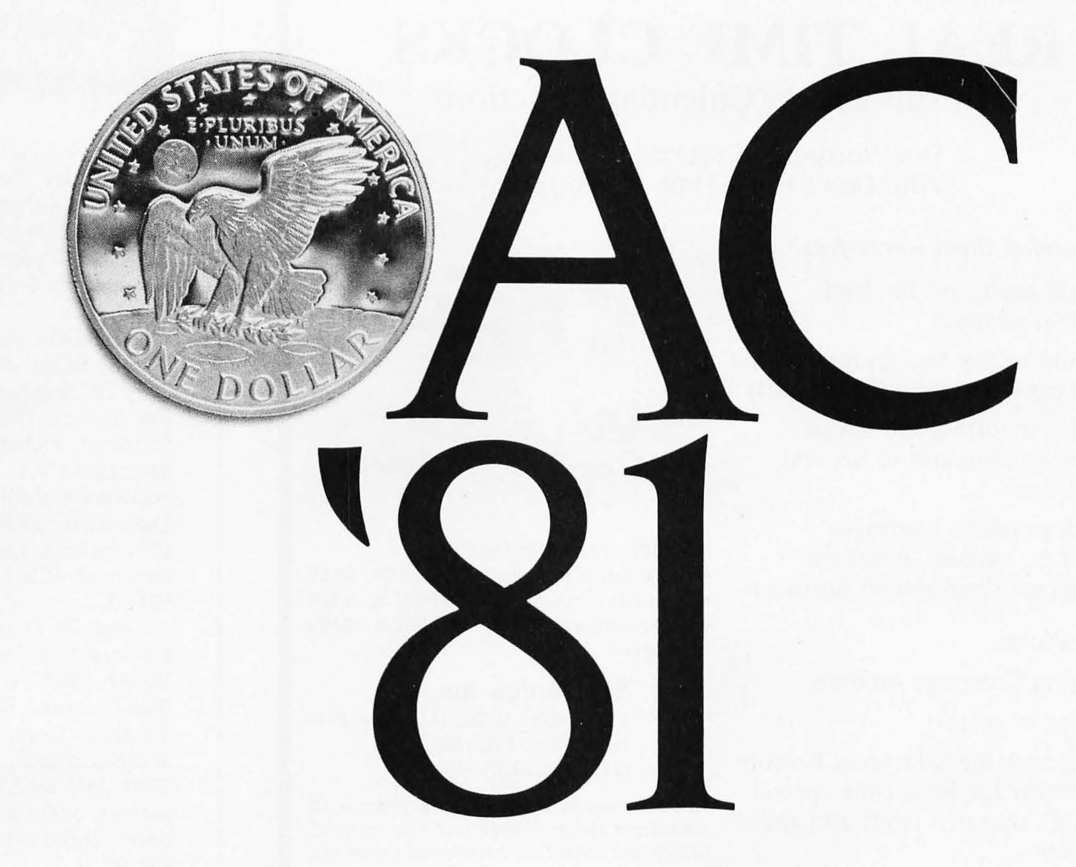
I can think of a few ways for you to build an under $50 computer, but not in less than a month. To keep costs down, it would have to be built from scratch. If it used a printed-circuit board, it would be much more expensive. There have been circuits for microcomputers in BYTE and other magazines many times within the past three years. I suggest you check the back issues or request an index from the magazines.

Once you have a circuit, you will still need the parts. You may be unaware that some companies, notably Intel, practically give away whole computers in the name of education. Write to Intel Corporation, calling attention of the product manager to the particular microprocessor you are interested in, and ask about the price and delivery of "University Kits." These are functional, cosmetically rejected devices that are practically given away for a nominal handling charge. In 1976, people were getting 8080A kits including programmable memory, EPROMS (erasable programmable read-only memories), and I/O (input/output) devices, worth about $800 from the distributors, for $20. I'm sure other companies have the same interest in supporting the schools.... **Steve**

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:

Ask BYTE
c/o Steve Ciarcia
POB 582
Glastonbury CT 06033

If you are a subscriber to The Source, send your questions by electronic mail or chat with Steve (TCE317) directly. Due to the high volume of inquiries, personal replies cannot be given. Be sure to include "Ask BYTE" in the address.



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Circle 262 on inquiry card.

Books Received

Beginning FORTRAN. Joe W McKinley. Portland OR: Matrix Publishers, 1980. 15.5 by 23 cm (6 by 9 inches), 240 pages, softcover, ISBN 0-916460-11-8, $9.95.

The BØØK Accessing the TRS-80 ROM. Raymond E Daly IV, Stephen C Hill, Roy Soltoff, Thomas B Stibolt Jr, Richard P Wilkes. Springfield VA: Insiders Software Consultants Inc, 1980. 22 by 27.5 cm (8½ by 10¾ inches), 126 pages, softcover, ISBN- none, $24.95.

Compiler Design and Construction. Arthur B Pyster, PhD. New York: Van Nostrand Reinhold Electrical/Computer Science and Engineering Series, 1980. 15.5 by 23 cm (6 by 9 inches), 384 pages, hardcover, ISBN 0-442-24394-4, $24.50.

Computing Principles and Techniques. B Vickery. Philadelphia PA: Heyden & Son, 1979. 15.5 by 22 cm (6 by 8½ inches), 182 pages, hardcover, ISBN 0-85274-505-2, $24.

The CP/M Handbook with MP/M. Rodnay Zaks. Berkeley CA: Sybex Inc, 1980. 13.1 by 22 cm (5⅜ by 8½ inches), 324 pages, softcover, ISBN 0-89588-048-2, $13.95.

Design of Solid-State Power Supplies, second edition. Eugene Hnatek. New York: Van Nostrand Reinhold, 1980. 15.6 by 23.5 cm (6⅜ by 9¼ inches), 621 pages, hardcover, ISBN 0-442-23429-5, $27.50.

The 8086 Book. Russell Rector, George Alexy. Berkeley CA: Osborne/McGraw-Hill, 1980. 16.5 by 23.5 cm (6½ by 9¼ inches), 249 pages, softcover, ISBN 0-931988-29-2, $9.95.

Foundations of Programming with Pascal. Lawrie Moore. Somerset NJ: John Wiley & Sons, 1980. 16 by 23.5 cm (6¼ by 9¼ inches), 238 pages, hardcover. ISBN 0-470-27022-5, $47.95.

How to Do Your Own Accounting for a Small Business. Robert R Milliron. Wilmington DE: Enterprise Publishing Inc, 1980. 22 by 28 cm (8½ by 11 inches), 178 pages, hardcover, ISBN 0-913864-34-X, $9.95. A practice manual for this book is $5.95.

Introduction to the Computer. Jeffrey Frates, William Moldrup. Englewood Cliffs NJ: Prentice-Hall Inc, 1980. 18.5 by 24.5 cm (7¼ by 9½ inches), 449 pages, hardcover, ISBN 0-13-480301-9, $17.95.

Journal of Digital Systems, volume 4. Waldo G Magnuson Jr. Potomac MD: Computer Science Press Inc, 1980. 15.5 by 23 cm (6 by 9 inches), 106 pages, softcover, ISBN 0195 4350, price individual $45, company $65.

Mathematics for Business and Economics with Computing. Frank Scalzo. Princeton NJ: Petrocelli Books, 1980. 16 by 23.5 cm (6¼ by 9¼ inches), 388 pages, hardcover, ISBN 0-89433-039-X, $27.

Microcomputer Interfacing. Bruce A Artwick. Englewood Cliffs NJ: Prentice-Hall Inc, 1980. 18.5 by 24.5 cm (7¼ by 9½ inches), 341 pages, hardcover, ISBN 0-13-580902-9, $21.95.

Microcomputer Interfacing. G Jack Lipovski. Lexington MA: Lexington Books, 1980. 15.5 by 23 cm (6 by 9 inches), 426 pages, hardcover, ISBN 0-669-03619-6, $24.95.

Microcomputers for External Devices. James A Gupton Jr. Portland OR: Dilithium Press, 1980. 14 by 20.5 cm (5½ by 8⅜ inches), 279 pages, softcover, ISBN 0-918398-28-2, $13.95.

Microprocessor Systems Design and Applications. Dave Bursky. Rochelle Park NJ: Hayden Book Company Inc, 1980. 22 by 28 cm (8½ by 11 inches), 192 pages, softcover, ISBN 0-8104-0976-3, $9.95.

Pathways Through the ROM, Guide to Level II BASIC and DOS. Robert M Richardson, Roger Fuller,

John T Phillipp, George Blank, and John Hartford. Milford NH: Softside Publications, 1980. 22 by 28 cm (8½ by 11 inches), 116 pages, softcover, ISBN-none, $19.95.

The Personal Computer Book. Robin Bradbeer. West Yorkshire, England: MCB Publications, 1980. 15 by 21 cm (5¾ by 8¼ inches), 210 pages, softcover, ISBN 0-905897-56-0. $15.

Theory and Design of Digital Computer Systems. Douglas Lewin. Englewood Cliffs NJ: Prentice-Hall Inc, 1980. 38 by 59.5 cm (15½ by 23½ inches), 472 pages, softcover, ISBN 0-470-26959-6, $21.95.

What to Do After You Hit Return. People's Computer Company. Rochelle Park NJ: Hayden Book Company Inc, 1980. 25.5 by 36 cm (10 by 14 inches), 180 pages, softcover, ISBN 0-8104-5476-9, $14.95.

Your First Computer: A Guide to Business and Personal Computing. Rodnay Zaks. Berkeley CA: Sybex Inc, 1980. 14 by 22 cm (5½ by 8½ inches), 260 pages, softcover, ISBN 0-89588-045-8, $7.95.■

These lists are of books and software packages received by BYTE Publications during the past month. The list of books is not meant to be exhaustive; its purpose is to acquaint our readers with recently published titles of interest. The list of software is correct to the best of our knowledge, but it is not meant to be a full description of the product. The form and version of the product as received by BYTE Publications is that listed here. The software list makes no comment on the quality or usefulness of the software. If you send us software, include the list price and note other distribution formats. We regret that we cannot review every book and software package we receive.

Software Received

B17 Tape Operating System. Cassette-based utility for the TRS-80. Cassette, $22. ABS Suppliers, POB 8297, Ann Arbor MI 48107.

EasyWriter (Professional System). Word processor for Apple II with 80-column video board. Floppy disk, $150. Information Unlimited Software, 281 Arlington Ave, Berkeley CA 94707.

UltraMon. Assembly-language monitor for the TRS-80. Cassette, $24.95. International Association of Programmers, POB 4211, Manchester NH 03103.

Write-On II. Word-processing software for Apple II. Floppy disk, $150. Rainbow Computing, 9719 Reseda Blvd, Northridge CA 91324.

Zork: The Great Underground Empire, Part I. Adventure game for the TRS-80. Floppy disk, $39.95. Personal Software, 1330 Bordeaux Dr, Sunnyvale CA 94086.■

BYTE's Bits

Education Foundation Awards Microcomputer Equipment

The Apple Education Foundation has awarded twenty-five recipients more than $150,000 of microcomputer equipment. Thirty-five microcomputer systems were awarded for projects at all scholastic levels, from elementary school to the university level, and for medical and special-education projects. A grand prize will be awarded to the institution or individual that demonstrates the most outstanding example of program development leading to improved education through the use of microcomputers.

These systems are being used in university biology study projects for developing and testing programs in genetics and cell metabolism, developing software for laboratory courses in psychology and education, assisting teachers in planning physical-education training for handicapped children, translating and adapting computer-assisted music programs to microcomputers, and developing programs for business forecasting and planning. Besides the uses in the universities, the systems are being employed in special educational areas to teach programming; time/money management for mentally disabled, prevocational students; typing; and to develop programs for autistic children. The systems are being used in elementary schools to teach and develop foundations in all academic disciplines.

The Apple Education Foundation, chartered in 1979, is a nonprofit corporation established to support and develop new methods of learning through the use of microcomputers. Most of the systems provided under

the grants are Apple II microcomputers. Other contributing organizations are Bell & Howell, Mountain Computer Inc, Heuristics Inc, Integral Data Systems Inc, Interactive Structures Inc, ABW Inc, and Videx. For more information, contact Apple Education Foundation, 20863 Stevens Creek Blvd, Cupertino CA 95014, (408) 255-3295.

Microcomputer User Software Library

The Home Computer Library is a service lending library for users of TRS-80 and Apple microcomputers. The Library lends books and software by mail, and plans to expand its services to include other microcomputers and systems, such as the Atari, PET, and Texas Instruments machines. Annual membership in the Library is $20, with a thirty-day money-back guarantee. Members can borrow books and software of their choice for a three-week period. There is a rental charge, which is usually $1 to $5. Emphasis is on stocking the Library with educational, small-business and home-application software. Members also have the opportunity to communicate directly with software authors and marketers as well as personal-computer manufacturers through the Feedback service, which surveys members for suggestions, changes, and additions they would like to see in hardware and software. For details, contact The Home Computer Library, Department B, 1469 Rosena Ave, Madison OH 44057, (216) 428-6163. ■

Micrograph continued:

Listing 1: *The second third of the firmware for Micrograph control, written for the Z80 microprocessor used in the prototype. The first fifteen pages of this listings were given in Part 1 of this article. The remaining portion of the firmware will be included in January 1981 BYTE's final installment of this series, along with a description of the software and an explanation of its use.*

```
                   ;                    E         (TEMPORARY)
                   ;                    H         (POINTER)
                   ;                    L         (POINTER)
                   ;
                   ; I/O                PORT 0    (DISPLAY CONTROL)
                   ;
                   ; STRUCTURES         GDR       (GRAPHIC DISPLAY REGISTERS)
                   ;
0387   E60F        LREG:   AND  00001111B                ;CLEAR OP CODE
0389   FE0F                CP   00001111B                ;TEST FOR RESET
038B   CA0000              JP   Z,RESTART                ;RESET IF GDR15
038E   6F                  LD   L,A                      ;LOAD LOAD BYTE
038F   2600                LD   H,0                      ;CLEAR POINTER
0391   118010              LD   DE,STRUCT+GDR            ;SET UP BASE ADDRESS
0394   19                  ADD  HL,DE                    ;ADD BASE ADDRESS
0395   CDED01              CALL FETCH                    ;GET THE DATA
0398   77                  LD   (HL),A                   ;SAVE THE DATA
0399   DD7E0E              LD   A,(IX+GDR14)             ;GET DISPLAY CONTROL
039C   D300                OUT  (0),A                    ;SENT THE DATA
039E   C9                  RET                           ;RETURN
                   ;
                   ; LSUB ***************************************************
                   ;
                   ; LSUB LOADS A SUBROUTINE INTO RAM AT THE SPECIFIED
                   ; ADDRESS AND WITH THE SPECIFIED LENGTH. LSUB FIRST
                   ; GETS THE SUBROUTINE NUMBER, THEN SETS THE LENGTH
                   ; IN SLONG. THE SUBROUTINE ADDRESS IS SAVED IN SLINK.
                   ; GETBLK IS THEN CALLED TO READ IN THE DATA.
                   ;
                   ; CALLS              FETCH
                   ;                    GETBLK
                   ;
                   ; CALLED BY          PRIMAT    (INDIRECTLY)
                   ;
                   ; REGISTERS          A         (PRIMITIVE OP CODE, TEMPORARY)
                   ;                    B         (LENGTH)
                   ;                    D         (POINTER)
                   ;                    E         (POINTER)
                   ;                    H         (POINTER)
                   ;                    L         (POINTER)
                   ;                    IY        (INDEX)
                   ;
                   ; I/O                NONE
                   ;
                   ; STRUCTURES         SLINK     (SUBROUTINE LINK)
                   ;                    SLONG     (SUBROUTINE LENGTH)
                   ;
039F   E60F        LSUB:   AND  00001111B                ;CLEAR OP CODE
03A1   5F                  LD   E,A                      ;MOVE OFFSET TO E
03A2   1600                LD   D,0                      ;CLEAR POINTER
03A4   FD21B010            LD   IY,STRUCT+SLONG          ;POINT TO SLONG
03A8   FD19                ADD  IY,DE                    ;ADD OFFSET
03AA   CDED01              CALL FETCH                    ;GET LENGTH
03AD   47                  LD   B,A                      ;SAVE LENGTH
03AE   FD7700              LD   (IY+0),A                 ;SAVE LENGTH
03B1   FD219010            LD   IY,STRUCT+SLINK          ;POINT TO SLINK
03B5   CB23                SLA  E                        ;SHIFT THE OFFSET
03B7   FD19                ADD  IY,DE                    ;ADD OFFSET
03B9   CDED01              CALL FETCH                    ;GET ADDRESS LOW BYTE
03BC   6F                  LD   L,A                      ;SAVE LOW BYTE
03BD   FD7700              LD   (IY+0),A                 ;SAVE LOW BYTE
```

Listing 1 continued on page 328

Listing 1 continued:

```
03C0   CDED01                CALL  FETCH            ;GET ADDRESS HIGH BYTE
03C3   67                    LD    H,A              ;SAVE HIGH BYTE
03C4   FD7701                LD    (IY+1),A         ;SAVE HIGH BYTE
03C7   CD9A08                CALL  GETBLK           ;GET DATA
03CA   C9                    RET                    ;RETURN
                     ;
                     ; LSYM ******************************************
                     ;
                     ; LSYM LOADS SYMBOL DEFINITIONS INTO THE INTERNAL
                     ; SYMBOL GENERATOR, SYMTAB. LSYM FIRST CHECKS TO SEE
                     ; IF ALL OR JUST ONE SYMBOL IS TO BE LOADED. IF ALL
                     ; ALL ARE TO BE LOADED, LSYM LOAD 1024 SYMBOL ELEMENTS
                     ; (FOR 128 SYMBOLS). OTHERWISE, LSYM LOADS 8 SYMBOL
                     ; ELEMENTS FOR ONE SYMBOL.
                     ;
                     ; CALLS          FETCH
                     ;                GETBLK
                     ;
                     ; CALLED BY      PRIMAT  (INDIRECTLY)
                     ;
                     ; REGISTERS      A       (PRIMITIVE OP CODE)
                     ;                B       (COUNTER)
                     ;                C       (COUNTER)
                     ;                H       (POINTER)
                     ;                L       (POINTER)
                     ;
                     ; I/O            NONE
                     ;
                     ; STRUCTURES     SYMTAB  (SYMBOL TABLE)
                     ;
03CB   CB47          LSYM:   BIT   0,A              ;TEST FOR LOAD TYPE
03CD   280E                  JR    Z,LSYM1          ;JUMP IF SINGLE LOAD
03CF   210014                LD    HL,SYMTAB        ;LOAD POINTER
03D2   0E04                  LD    C,4              ;LOAD COUNT
03D4   0600          LSYM0:  LD    B,0              ;SET COUNT OF 256
03D6   CD9A08                CALL  GETBLK           ;GET DATA
03D9   0D                    DEC   C                ;DECREMENT COUNT
03DA   20F8                  JR    NZ,LSYM0         ;JUMP IF NOT DONE
03DC   C9                    RET                    ;RETURN
03DD   CDED01        LSYM1:  CALL  FETCH            ;GET SYMBOL NUMBER
03E0   E67F                  AND   01111111B        ;MASK HIGH BIT
03E2   6F                    LD    L,A              ;SAVE OFFSET
03E3   2600                  LD    H,0              ;CLEAR POINTER
03E5   CB25                  SLA   L                ;SHIFT OVER
03E7   CB14                  RL    H                ;   THREE BITS
03E9   CB25                  SLA   L                ;   TO PROPERLY
03EB   CB14                  RL    H                ;   COMPUTE
03ED   CB25                  SLA   L                ;   THE
03EF   CB14                  RL    H                ;   OFFSET
03F1   010014                LD    BC,SYMTAB        ;POINT TO SYMTAB
03F4   09                    ADD   HL,BC            ;ADD BASE ADDRESS
03F5   0608                  LD    B,8              ;SET COUNT
03F7   CD9A08                CALL  GETBLK           ;GET DATA
03FA   C9                    RET                    ;RETURN
                     ;
                     ; MOV *******************************************
                     ;
                     ; MOV MOVES THE CURRENT XY POSITION. THE XY POSITION
                     ; MAY BE UPDATED BY ABSOLUTE OR RELATIVE OFFSETS,
                     ; AND BY LONG OR SHORT OFFSETS. THE POINT MAY OR MAY
                     ; NOT BE ILLUMINATED IN EITHER THE PRIMARY OR SECONDARY
                     ; COLOR. MOV FIRST DETERMINES THE NEW XY LOCATION
                     ; BY ADDING OFFSETS IF THEY ARE RELATIVE, ARE BY
```

Listing 1 continued:

```
                 ; LOADING NEW POSITIONS. MOV NEXT CHECKS TO SEE IF
                 ; THE POINT WILL BE ILLUMINATED. IF SO, THE PROPER
                 ; COLOR IS INSERTED AT THAT PIXEL.
                 ;
                 ; CALLS           CASE
                 ;                 FETCH
                 ;                 PUT
                 ;
                 ; CALLED BY       PRIMAT    (INDIRECTLY)
                 ;
                 ; REGISTERS       A         (PRIMITIVE OP CODE, TEMPORARY)
                 ;                 B         (CASE)
                 ;                 C         (TEMPORARY)
                 ;                 D         (TEMPORARY X)
                 ;                 E         (TEMPORARY Y)
                 ;                 IX        (INDEX)
                 ;
                 ; I/O             NONE
                 ;
                 ; STRUCTURES      GDR0      (X)
                 ;                 GDR1      (Y)
                 ;                 GDR2      (PRIMARY COLOR)
                 ;                 GDR3      (SECONDARY COLOR)
                 ;                 GDR5      (VECTOR MODE)
                 ;                 REF       (REFERENCE)
                 ;
03FB  4F         MOV:    LD    C,A              ;SAVE A COPY OF A
03FC  DD7E05             LD    A,(IX+GDR5)      ;GET VECTOR MODE
03FF  DD7743             LD    (IX+REF),A       ;SAVE REFERENCE
0402  CDA007             CALL  CASE             ;DETERMINE CASE
0405  DD5600             LD    D,(IX+GDR0)      ;GET X
0408  DD5E01             LD    E,(IX+GDR1)      ;GET Y
040B  CDED01             CALL  FETCH            ;GET DATA
040E  CB59               BIT   3,C              ;TEST IF LONG
0410  2036               JR    NZ,MOV3          ;JUMP IF LONG
0412  CB51               BIT   2,C              ;TEST IF ABSOLUTE
0414  2022               JR    NZ,MOV2          ;JUMP IF ABSOLUTE
0416  F5                 PUSH  AF               ;SAVE A COPY OF A
0417  CB3F               SRL   A                ;SHIFT OVER
0419  CB3F               SRL   A                ;   FOUR BITS
041B  CB3F               SRL   A                ;   TO MASK ALL BUT
041D  CB3F               SRL   A                ;   X OFFSET
041F  CB5F               BIT   3,A              ;TEST SIGN OF OFFSET
0421  2804               JR    Z,MOV0           ;JUMP IF POSITIVE
0423  CB9F               RES   3,A              ;CLEAR SIGN
0425  ED44               NEG                    ;NEGATE THE VALUE
0427  82         MOV0:   ADD   A,D              ;ADD THE OFFSET TO X
0428  57                 LD    D,A              ;SAVE THE NEW VALUE
0429  F1                 POP   AF               ;RESTORE A
042A  E60F               AND   00001111B        ;MASK ALL BUT Y OFFSET
042C  CB5F               BIT   3,A              ;TEST SIGN OF OFFSET
042E  2804               JR    Z,MOV1           ;JUMP IF POSITIVE
0430  CB9F               RES   3,A              ;CLEAR SIGN
0432  ED44               NEG                    ;NEGATE THE VALUE
0434  83         MOV1:   ADD   A,E              ;ADD THE OFFSET TO Y
0435  5F                 LD    E,A              ;SAVE THE NEW VALUE
0436  1832               JR    MOV7             ;JUMP TO PROCESS POINT
0438  F5         MOV2:   PUSH  AF               ;SAVE A COPY OF A
0439  CB3F               SRL   A                ;SHIFT OVER
043B  CB3F               SRL   A                ;   FOUR BITS
043D  CB3F               SRL   A                ;   TO MASK ALL BUT
043F  CB3F               SRL   A                ;   X OFFSET
0441  57                 LD    D,A              ;SAVE THE NEW VALUE
0442  F1                 POP   AF               ;RESTORE A
```

Listing 1 continued on page 330

Listing 1 continued:

```
0443  E60F                AND   00001111B          ;MASK ALL BUT Y OFFSET
0445  5F                  LD    E,A                ;SAVE THE NEW VALUE
0446  1822                JR    MOV7               ;JUMP TO PROCESS POINT
0448  CB51         MOV3:  BIT   2,C                ;TEST FOR ABSOLUTE
044A  2019                JR    NZ,MOV6            ;JUMP IF ABSOLUTE
044C  CB7F                BIT   7,A                ;TEST SIGN OF OFFSET
044E  2804                JR    Z,MOV4             ;JUMP IF POSITIVE
0450  CBBF                RES   7,A                ;CLEAR SIGN
0452  ED44                NEG                      ;NEGATE THE VALUE
0454  82           MOV4:  ADD   A,D                ;ADD THE OFFSET
0455  57                  LD    D,A                ;SAVE THE NEW VALUE
0456  CDED01              CALL  FETCH              ;GET THE NEXT DATA
0459  CB7F                BIT   7,A                ;TEST SIGN OF OFFSET
045B  2804                JR    Z,MOV5             ;JUMP IF POSITIVE
045D  CBBF                RES   7,A                ;CLEAR SIGN
045F  ED44                NEG                      ;NEGATE THE VALUE
0461  83           MOV5:  ADD   A,E                ;ADD THE OFFSET
0462  5F                  LD    E,A                ;SAVE THE NEW VALUE
0463  1805                JR    MOV7               ;JUMP TO PROCESS POINT
0465  57           MOV6:  LD    D,A                ;SAVE THE NEW VALUE
0466  CDED01              CALL  FETCH              ;GET THE NEXT DATA
0469  5F                  LD    E,A                ;SAVE THE NEW VALUE
046A  DD7200       MOV7:  LD    (IX+GDR0),D        ;UPDATE X
046D  DD7301              LD    (IX+GDR1),E        ;UPDATE Y
0470  CB41                BIT   0,C                ;TEST ILLUMINATE
0472  2001                JR    NZ,MOV8            ;JUMP IF ILLUMINATE
0474  C9                  RET                      ;RETURN
0475  DD7E02       MOV8:  LD    A,(IX+GDR2)        ;LOAD PRIMARY COLOR
0478  CB49                BIT   1,C                ;TEST COLOR TYPE
047A  2803                JR    Z,MOV9             ;JUMP IF PRIMARY
047C  DD7E03              LD    A,(IX+GDR3)        ;LOAD SECONDARY COLOR
047F  0E01         MOV9:  LD    C,1                ;ASSUME SUCCESS
0481  CD7E0A              CALL  PUT                ;PUT THE POINT
0484  C9                  RET                      ;RETURN
                   ;
                   ; RCRAM *******************************************
                   ;
                   ; RCRAM DUMPS THE COLOR RAMS. RCRAM FIRST DETERMINES
                   ; IF A SINGLE OR ALL COLOR RAMS ARE TO BE DUMPED. IF
                   ; A SINGLE COLOR RAM IS TO BE DUMPED, THE ENTIRE RAM
                   ; OR A SINGLE ADDRESS OF THAT RAM IS DUMPED. OTHERWISE,
                   ; ALL THREE COLOR RAMS ARE EITHER ENTIRELY DUMPED OR
                   ; A SINGLE ADDRESS OF ALL THREE ARE DUMPED.
                   ;
                   ; CALLS           FETCH
                   ;                 SENDBK
                   ;                 SENDBY
                   ;
                   ; CALLED BY       PRIMAT (INDIRECTLY)
                   ;
                   ; REGISTERS       A       (PRIMITIVE OP CODE)
                   ;                 B       (COUNTER)
                   ;                 D       (TEMPORARY)
                   ;                 E       (TEMPORARY)
                   ;                 H       (POINTER)
                   ;                 L       (POINTER)
                   ;                 IY      (INDEX)
                   ;
                   ; I/O             NONE
                   ;
                   ; STRUCTURES      CR0     (COLOR RAM 0)
                   ;                 CR1     (COLOR RAM 1)
                   ;                 CR2     (COLOR RAM 2)
                   ;
0485  CB47         RCRAM: BIT   0,A                ;TEST SINGLE BIT
```

Listing 1 continued:

```
0487  2820                  JR    Z,RCRAM2        ;JUMP IF SINGLE
0489  FE7D                  CP    01111101B       ;TEST REFERENCE
048B  2009                  JR    NZ,RCRAM0       ;JUMP IF NOT ALL
048D  0630                  LD    B,48            ;SET COUNT OF 48
048F  21001C                LD    HL,CR0          ;SET BASE ADDRESS
0492  CD880A                CALL  SENDBK          ;SEND THE DATA
0495  C9                    RET                   ;RETURN
0496  0610        RCRAM0:   LD    B,16            ;SET COUNT OF 16
0498  E60C        RCRAM1:   AND   00001100B       ;MASK OP CODE
049A  CB27                  SLA   A               ;SHIFT OFFSET
049C  CB27                  SLA   A               ;SHIFT OFFSET
049E  6F                    LD    L,A             ;SAVE OFFSET
049F  2600                  LD    H,0             ;CLEAR POINTER
04A1  11001C                LD    DE,CR0          ;SET BASE ADDRESS
04A4  19                    ADD   HL,DE           ;ADD BASE TO OFFSET
04A5  CD880A                CALL  SENDBK          ;SEND THE DATA
04A8  C9                    RET                   ;RETURN
04A9  FE7C        RCRAM2:   CP    01111100B       ;TEST REFERENCE
04AB  2027                  JR    NZ,RCRAM3       ;JUMP IF NOT ALL
04AD  CDED01                CALL  FETCH           ;GET OFFSET
04B0  E60F                  AND   00001111B       ;MASK THE OFFSET
04B2  6F                    LD    L,A             ;SAVE OFFSET
04B3  2600                  LD    H,0             ;CLEAR POINTER
04B5  11001C                LD    DE,CR0          ;SET BASE ADDRESS
04B8  19                    ADD   HL,DE           ;ADD BASE TO OFFSET
04B9  5D                    LD    E,L             ;SAVE THE POINTER
04BA  54                    LD    D,H             ;SAVE THE POINTER
04BB  FD210000              LD    IY,0            ;CLEAR THE POINTER
04BF  FD19                  ADD   IY,DE           ;SAVE INDEX
04C1  FD7E00                LD    A,(IY+0)        ;GET DATA
04C4  CD910A                CALL  SENDBY          ;SEND THE DATA
04C7  FD7E10                LD    A,(IY+16)       ;GET DATA
04CA  CD910A                CALL  SENDBY          ;SEND THE DATA
04CD  FD7E20                LD    A,(IY+32)       ;GET DATA
04D0  CD910A                CALL  SENDBY          ;SEND THE DATA
04D3  C9                    RET                   ;RETURN
04D4  0601        RCRAM3:   LD    B,1             ;SET THE COUNT
04D6  E60C                  AND   00001100B       ;MASK OP CODE
04D8  CB27                  SLA   A               ;SHIFT OFFSET
04DA  CB27                  SLA   A               ;SHIFT OFFSET
04DC  6F                    LD    L,A             ;SAVE OFFSET
04DD  2600                  LD    H,0             ;CLEAR POINTER
04DF  CDED01                CALL  FETCH           ;GET OFFSET
04E2  E60F                  AND   00001111B       ;MASK THE OFFSET
04E4  85                    ADD   A,L             ;ADD OFFSET
04E5  6F                    LD    L,A             ;SAVE OFFSET
04E6  11001C                LD    DE,CR0          ;SET BASE ADDRESS
04E9  19                    ADD   HL,DE           ;ADD BASE TO OFFSET
04EA  CD880A                CALL  SENDBK          ;SENT THE DATA
04ED  C9                    RET                   ;RETURN
                  ;
                  ; RETN ************************************************
                  ;
                  ; RETN RETURNS FROM A GRAPHICS SUBROUTINE. RETN FIRST
                  ; CHECKS SPTR TO SEE IF A SUBROUTINE IS IN PROGRESS.
                  ; IF NOT, RETN SIMPLY RETURNS. IF SO, RETN POPS
                  ; SOFF AND SPTR FROM GSTACK AND RETURNS.
                  ;
                  ; CALLS          NONE
                  ;
                  ; CALLED BY      PRIMAT   (INDIRECTLY)
                  ;
                  ; REGISTERS      A        (PRIMITIVE OP CODE)
                  ;                D        (TEMPORARY)
```

Listing 1 continued on page 332

Listing 1 continued:

```
                ;                   E        (TEMPORARY)
                ;                   H        (POINTER)
                ;                   L        (POINTER)
                ;                   IX       (INDEX)
                ;
                ; I/O               NONE
                ;
                ; STRUCTURES        GPC      (GRAPHICS STACK POINTER)
                ;                   GSTACK   (GRAPHICS STACK)
                ;                   SOFF     (SUBROUTINE OFFSET)
                ;                   SPTR     (SUBROUTINE POINTER)
                ;
04EE  DDCB405E  RETN:    BIT  3,(IX+SPTR)          ;TEST SPTR
04F2  C8                 RET  Z                    ;RETURN IF ZERO
04F3  DD3542             DEC  (IX+GPC)             ;UPDATE THE STACK
04F6  DD5E42             LD   E,(IX+GPC)           ;LOAD GPC
04F9  1600               LD   D,0                  ;CLEAR POINTER
04FB  217F10             LD   HL,GSTACK            ;SET INDEX TO GSTACK
04FE  B7                 OR   A                    ;CLEAR THE CARRY
04FF  ED52               SBC  HL,DE                ;SUBTRACT OFFSET
0501  7E                 LD   A,(HL)               ;POP SOFF
0502  DD7741             LD   (IX+SOFF),A          ;RETURN SOFF
0505  23                 INC  HL                   ;UPDATE THE POINTER
0506  7E                 LD   A,(HL)               ;POP SPTR
0507  DD7740             LD   (IX+SPTR),A          ;RETURN SPTR
050A  DD3542             DEC  (IX+GPC)             ;DECREMENT OFFSET
050D  C9                 RET                       ;RETURN
                ;
                ; RPIX ***********************************************
                ;
                ; RPIX READS PIXEL DATA ACCORDING TO THE GIVEN
                ; REFERENCE. RPIX CAN DUMP EITHER FULL FRAME, ONE
                ; PIXEL AT XY, OR AN ENTIRE VIEWPORT. RPIX FIRST CHECKS
                ; TO SEE IF ONLY A SINGLE POINT IS TO BE DUMPED. IF SO,
                ; RPIX DUMPS THE POINT AT XY. OTHERWISE, RPIX SETS A
                ; FLAG IF FULL FRAME IS SET. X AND Y ARE CLEARED, AND
                ; RPIX PROCEDES FROM THE ORIGIN TO THE MAXIMUM X AND Y
                ; VALUES, LEFT TO RIGHT, BOTTOM TO TOP. IF FULL FRAME
                ; IS SET, ALL PIXELS ARE DUMPED. OTHERWISE, THE
                ; CASE AND CLIPPING SUCCESS ARE CHECKED. IF THE PIXEL
                ; IS VISIBLE, THE PIXEL IS DUMPED. RPIX COMPLETES
                ; WHEN X AND Y HAVE RECYCLED TO THE ORIGIN.
                ;
                ; CALLS             SENDBY
                ;                   CASE
                ;                   CLIP
                ;                   PEEK
                ;
                ; CALLED BY         PRIMAT   (INDIRECTLY)
                ;
                ; REGISTERS         A        (PRIMITIVE OP CODE)
                ;                   B        (CASE)
                ;                   C        (CLIP SUCCESS)
                ;                   D        (FULL FRAME FLAG)
                ;                   IX       (INDEX)
                ;
                ; I/O               NONE
                ;
                ; STRUCTURES        GDR0     (X)
                ;                   GDR1     (Y)
                ;                   REF      (REFERENCE)
                ;
050E  1600      RPIX:    LD   D,0                  ;CLEAR FULL FRAME FLAG
0510  E60F               AND  00001111B            ;MASK OP CODE
0512  DD7743             LD   (IX+REF),A           ;SAVE REFERENCE
```

Listing 1 continued:

```
0515  DDCB433E             SRL   (IX+REF)          ;SHIFT REFERENCE
0519  DDCB433E             SRL   (IX+REF)          ;SHIFT REFERENCE
051D  CB5F                 BIT   3,A               ;TEST REFERENCE
051F  280F                 JR    Z,RPIX1           ;JUMP IF VP REFERENCE
0521  CB57                 BIT   2,A               ;TEST REFERENCE
0523  2807                 JR    Z,RPIX0           ;JUMP IF FULL FRAME
0525  CDA408               CALL  PEEK              ;GET DATA
0528  CD910A               CALL  SENDBY            ;SEND THE DATA
052B  C9                   RET                     ;RETURN
052C  1601         RPIX0:  LD    D,1               ;SET FULL FRAME FLAG
052E  1803                 JR    RPIX2             ;JUMP
0530  CDA007       RPIX1:  CALL  CASE              ;DETERMINE CASE
0533  DD360000     RPIX2:  LD    (IX+GDR0),0       ;CLEAR X
0537  DD360100             LD    (IX+GDR1),0       ;CLEAR Y
053B  CB42         RPIX3:  BIT   0,D               ;TEST D
053D  2007                 JR    NZ,RPIX4          ;JUMP IF FULL FRAME
053F  CDEF07               CALL  CLIP              ;TEST FOR CLIP
0542  CB41                 BIT   0,C               ;TEST SUCCESS
0544  2806                 JR    Z,RPIX5           ;JUMP IF CLIPPED
0546  CDA408       RPIX4:  CALL  PEEK              ;READ THE DATA
0549  CD910A               CALL  SENDBY            ;SEND THE DATA
054C  DD3400       RPIX5:  INC   (IX+GDR0)         ;INCREMENT X
054F  20EA                 JR    NZ,RPIX3          ;JUMP IF NOT ZERO
0551  DD3401               INC   (IX+GDR1)         ;INCREMENT Y
0554  20E5                 JR    NZ,RPIX3          ;JUMP IF NOT ZERO
0556  C9                   RET                     ;RETURN
                   ;
                   ; RREG ***********************************************
                   ;
                   ; RREG RETURNS THE VALUE OF THE DESIGNATED GRAPHICS
                   ; DISPLAY REGISTER. RREG FIRST DETERMINES THE REGISTER
                   ; NUMBER, THEN RETURNS THE VALUE VIA SENDBY.
                   ;
                   ; CALLS           SENDBY
                   ;
                   ; CALLED BY       PRIMAT   (INDIRECTLY)
                   ;
                   ; REGISTERS       A        (PRIMITIVE OP CODE)
                   ;                 D        (TEMPORARY)
                   ;                 E        (TEMPORARY)
                   ;                 H        (POINTER)
                   ;                 L        (POINTER)
                   ;
                   ; I/O             NONE
                   ;
                   ; STRUCTURES      GDR      (GRAPHICS DISPLAY REGISTERS)
                   ;
0557  E60F         RREG:   AND   00001111B         ;MASK OFF OP CODE
0559  6F                   LD    L,A               ;LOAD OFFSET
055A  2600                 LD    H,0               ;CLEAR POINTER
055C  118010               LD    DE,STRUCT+GDR     ;SET BASE ADDRESS
055F  19                   ADD   HL,DE             ;ADD OFFSET
0560  7E                   LD    A,(HL)            ;GET THE REGISTER
0561  CD910A               CALL  SENDBY            ;SEND THE DATA
0564  C9                   RET                     ;RETURN
                   ;
                   ; RSUB ***********************************************
                   ;
                   ; RSUB DUMPS A SUBROUTINE TO THE HOST. RSUB FIRST
                   ; IDENTIFIES THE SUBROUTINE NUMBER AND DETERMINES THE
                   ; START ADDRESS VIA SLINK. SLONG ENTRIES DETERMINE THE
                   ; SUBROUTINE LENGTH. RSUB CALLS SENDBK TO DUMP THE
                   ; DATA.
                   ;
                   ; CALLS           SENDBK
```

Listing 1 continued on page 334

Listing 1 continued:

```
                ;
                ; CALLED BY         PRIMAT    (INDIRECTLY)
                ;
                ; REGISTERS         A         (PRIMITIVE OP CODE)
                ;                   B         (COUNT)
                ;                   D         (POINTER)
                ;                   E         (POINTER)
                ;                   H         (POINTER)
                ;                   L         (POINTER)
                ;                   IX        (INDEX)
                ;                   IY        (INDEX)
                ;
                ; I/O               NONE
                ;
                ; STRUCTURES        SLINK     (SUBROUTINE LINKAGE)
                ;                   SLONG     (SUBROUTINE LENGTH)
                ;
0565  E60F      RSUB:   AND   00001111B           ;CLEAR OP CODE
0567  5F                LD    E,A                 ;SAVE OFFSET
0568  1600              LD    D,0                 ;CLEAR POINTER
056A  CB23              SLA   E                   ;SHIFT THE OFFSET
056C  FD219010          LD    IY,STRUCT+SLINK     ;GET LINKAGE
0570  FD19              ADD   IY,DE               ;ADD OFFSET
0572  FD6E00            LD    L,(IY+0)            ;GET LOW BYTE OF START
0575  FD6601            LD    H,(IY+1)            ;GET HIGH BYTE OF START
0578  FD21B010          LD    IY,STRUCT+SLONG     ;GET LENGTH
057C  CB3B              SRL   E                   ;SHIFT THE OFFSET
057E  FD19              ADD   IY,DE               ;ADD OFFSET
0580  FD4600            LD    B,(IY+0)            ;GET LENGTH
0583  CD880A            CALL  SENDBK              ;SEND THE DATA
0586  C9                RET                       ;RETURN
                ;
                ; RSYM *******************************************
                ;
                ; RSYM DUMPS A SINGLE OR THE ENTIRE SET OF SYMBOLS.
                ; RSYM FIRST DETERMINES IF A SINGLE SYMBOL IS TO BE
                ; DUMPED. IF SO, THE 8 BYTES DEFINING THE SYMBOL ARE
                ; FOUND AND DUMPED. OTHERWISE, THE ENTIRE SET OF
                ; SYMBOLS IS DUMPED.
                ;
                ; CALLS             FETCH
                ;                   SENDBK
                ;
                ; CALLED BY         PRIMAT    (INDIRECTLY)
                ;
                ; REGISTERS         A         (PRIMITIVE OP CODE)
                ;                   B         (COUNT)
                ;                   C         (TEMPORARY)
                ;                   H         (POINTER)
                ;                   L         (POINTER)
                ;
                ; I/O               NONE
                ;
                ; STTRUCTURES       SYMTAB    (SYMBOL TABLE)
                ;
0587  CB47      RSYM:   BIT   0,A                 ;TEST FOR ALL
0589  201E              JR    NZ,RSYM0            ;JUMP IF ALL
058B  CDED01            CALL  FETCH               ;GET ADDRESS
058E  E67F              AND   01111111B           ;MASK THE MSB
0590  6F                LD    L,A                 ;SAVE OFFSET
0591  2600              LD    H,0                 ;CLEAR POINTER
0593  010014            LD    BC,SYMTAB           ;POINT TO START
0596  CB25              SLA   L                   ;SHIFT OFFSET
0598  CB14              RL    H                   ;   THREE
059A  CB25              SLA   L                   ;   BITS TO
```

Listing 1 continued:

```
059C  CB14              RL   H           ;   PROPERLY
059E  CB25              SLA  L           ;   COMPUTE THE
05A0  CB14              RL   H           ;   OFFSET
05A2  09                ADD  HL,BC       ;ADD BASE ADDRESS
05A3  0608              LD   B,8         ;LOAD COUNT
05A5  CD880A            CALL SENDBK      ;SEND THE DATA
05A8  C9                RET              ;RETURN
05A9  210014    RSYMO:  LD   HL,SYMTAB   ;POINT TO START
05AC  0600              LD   B,0         ;SET COUNT OF 265
05AE  CD880A            CALL SENDBK      ;SEND 256 BYTES
05B1  CD880A            CALL SENDBK      ;SEND 256 BYTES
05B4  CD880A            CALL SENDBK      ;SEND 256 BYTES
05B7  CD880A            CALL SENDBK      ;SEND 256 BYTES
05BA  C9                RET              ;RETURN
                ;
                ; SYM ***********************************************
                ;
                ; SYM DISPLAYS A STRING OF SYMBOLS STARTING AT THE
                ; CURRENT XY POSITION. SYM FIRST DETERMINES THE
                ; NUMBER OF SYMBOLS, THEN READS IN THE SYMBOL CODE
                ; POINTING TO THE APPROPRIATE SYMTAB ENTRY. XY
                ; POINTS TO THE LOWER LEFT CORNER OF THE SYMBOL. SYMTAB
                ; ENTRIES ARE FETCHED FOR DISPLAY OF THE 8 X 8 MATRIX
                ; WHICH DEFINES THE SYMBOL.
                ;
                ; CALLS          FETCH
                ;                CASE
                ;                PUT
                ;
                ; CALLED BY      PRIMAT  (INDIRECTLY)
                ;
                ; REGISTERS      A       (PRIMITIVE OP CODE, TEMPORARY)
                ;                B       (CASE)
                ;                C       (SUCCESS)
                ;                D       (ROW COUNT)
                ;                E       (COLUMN COUNT)
                ;                H       (CHARACTER COUNT)
                ;                L       (TEMPORARY)
                ;                IX      (INDEX)
                ;                IY      (INDEX)
                ;
                ; I/O            NONE
                ;
                ; STRUCTURES     GDR0    (X)
                ;                GDR1    (Y)
                ;                GDR2    (PRIMARY COLOR)
                ;                GDR3    (SECONDARY COLOR)
                ;                GDR5    (VECTOR MODE)
                ;                SYMTAB  (SYMBOL TABLE)
                ;
05BB  E60F      SYM:    AND  00001111B   ;MASK THE OP CODE
05BD  67                LD   H,A         ;SAVE THE COUNT
05BE  DD7E05            LD   A,(IX+GDR5) ;GET THE VECTOR MODE
05C1  DD7743            LD   (IX+REF),A  ;SAVE THE REFERENCE
05C4  CDA007            CALL CASE        ;DETERMINE THE CASE
05C7  0E01              LD   C,1         ;ASSUME A SUCCESS
05C9  DD3501            DEC  (IX+GDR1)   ;BACK UP ONE SPACE
05CC  DD7E00            LD   A,(IX+GDR0) ;GET X
05CF  D608              SUB  8           ;MOVE BACK 8
05D1  DD7700            LD   (IX+GDR0),A ;SAVE X
05D4  DD3401    SYM0:   INC  (IX+GDR1)   ;MOVE UP ONE SPACE
05D7  DD7E00            LD   A,(IX+GDR0) ;GET X
05DA  C608              ADD  A,8         ;MOVE AHEAD 8
05DC  DD7700            LD   (IX+GDR0),A ;SAVE X
```

Listing 1 continued on page 336

Listing 1 continued:

```
05DF  7C                    LD    A,H            ;GET CHARACTER COUNT
05E0  FE00                  CP    0              ;COMPARE WITH ZERO
05E2  C8                    RET   Z              ;RETURN IF ZERO
05E3  25                    DEC   H              ;DECREMENT COUNT
05E4  DD7E01                LD    A,(IX+GDR1)    ;GET Y
05E7  C607                  ADD   A,7            ;ADD 7
05E9  DD7701                LD    (IX+GDR1),A    ;RESTORE Y
05EC  CDED01                CALL  FETCH          ;GET CHARACTER CODE
05EF  E67F                  AND   01111111B      ;MASK THE HIGH BIT
05F1  5F                    LD    E,A            ;SAVE CODE
05F2  1600                  LD    D,0            ;CLEAR POINTER
05F4  CB23                  SLA   E              ;SHIFT BY
05F6  CB12                  RL    D              ;    THREE
05F8  CB23                  SLA   E              ;    BITS TO
05FA  CB12                  RL    D              ;    PROPERLY
05FC  CB23                  SLA   E              ;    COMPUTE AN
05FE  CB12                  RL    D              ;    OFFSET
0600  FD210014              LD    IY,SYMTAB      ;LOAD THE BASE ADDRESS
0604  FD19                  ADD   IY,DE          ;ADD THE OFFSET
0606  1608                  LD    D,8            ;LOAD THE ROW COUNT
0608  DD3400        SYM1:   INC   (IX+GDR0)      ;UPDATE X
060B  7A                    LD    A,D            ;GET THE COUNT
060C  FE00                  CP    0              ;COMARE WITH ZERO
060E  28C4                  JR    Z,SYM0         ;JUMP IF ZERO
0610  DD3500                DEC   (IX+GDR0)      ;RESTORE THE POSITION
0613  15                    DEC   D              ;OTHERWISE DECREMENT
0614  FD7E00                LD    A,(IY+0)       ;GET CHARACTER MASK
0617  FD23                  INC   IY             ;POINT TO NEXT MASK
0619  1E08                  LD    E,8            ;SET COLUMN COUNT
061B  6F                    LD    L,A            ;SAVE THE MASK
061C  7B            SYM2:   LD    A,E            ;GET THE COLUMN COUNT
061D  FE00                  CP    0              ;COMPARE WITH ZERO
061F  200D                  JR    NZ,SYM3        ;JUMP IF NON ZERO
0621  DD7E00                LD    A,(IX+GDR0)    ;GET X
0624  D608                  SUB   8              ;DECREMENT BY 8
0626  DD7700                LD    (IX+GDR0),A    ;RESTORE X
0629  DD3501                DEC   (IX+GDR1)      ;DECREMENT Y
062C  18DA                  JR    SYM1           ;JUMP TO SYM1
062E  7D            SYM3:   LD    A,L            ;RESTORE MASK
062F  1D                    DEC   E              ;DECREMENT COLUMN COUNT
0630  CB27                  SLA   A              ;SHIFT TO CARRY
0632  3806                  JR    C,SYM4         ;JUMP IF CARRY
0634  6F                    LD    L,A            ;SAVE MASK
0635  DD7E03                LD    A,(IX+GDR3)    ;LOAD SECONDARY COLOR
0638  1804                  JR    SYM5           ;JUMP AROUND
063A  6F            SYM4:   LD    L,A            ;SAVE MASK
063B  DD7E02                LD    A,(IX+GDR2)    ;LOAD PRIMARY COLOR
063E  CD7E0A        SYM5:   CALL  PUT            ;PUT THE POINT
0641  DD3400                INC   (IX+GDR0)      ;INCREMENT X
0644  18D6                  JR    SYM2           ;JUMP BACK
                    ;
                    ; VEC *******************            ********
                    ;

                    ; TO A SPECIFIED ENDPOINT. VEC FIRST DETERMINES THE
                    ; REFERENCE OF THE VECTOR, THEN DETERMINES THE NEW
                    ; ENDPOINTS. THE ENDPOINTS MAY BE COMPUTED ABSOLUTE,
                    ; RELATIVE, SHORT, OR LONG. AFTER THE ENDPOINTS ARE
                    ; SET, THE VECTOR COLOR IS DETERMINED. PLOTTING THEN
                    ; BEGINS, USING A SCAN LINE CONVERSION ALGORITHM.
                    ; PLOTTING STOPS WHEN THE ENDPOINTS ARE REACHED.
                    ;
                    ; CALLS          FETCH
                    ;                CASE
```

Listing 1 continued:

```
                ;                   PLOT
                ;
                ; CALLED BY         PRIMAT   (INDIRECTLY)
                ;
                ; REGISTERS         A        (PRIMITIVE OP CODE, TEMPORARY)
                ;                   B        (CASE)
                ;                   C        (COUNTER)
                ;                   D        (ABSOLUTE DELTA X)
                ;                   E        (ABSOLUTE DELTA Y)
                ;                   H        (X INCREMENT)
                ;                   L        (Y INCREMENT)
                ;                   IX       (INDEX)
                ;
                ; I/O               NONE
                ;
                ; STRUCTURES        GDR0     (X)
                ;                   GDR1     (Y)
                ;                   GDR2     (PRIMARY COLOR)
                ;                   GDR3     (SECONDARY COLOR)
                ;                   GDR5     (VECTOR MODE)
                ;                   M        (VECTOR VARIABLE)
                ;                   MN       (VECTOR VARIABLE)
                ;                   SX       (VECTOR VARIABLE)
                ;                   SY       (VECTOR VARIABLE)
                ;
0646   4F       VEC:    LD   C,A              ;SAVE THE FLAGS
0647   DD7E05           LD   A,(IX+GDR5)      ;GET THE VECTOR MODE
064A   DD7743           LD   (IX+REF),A       ;SAVE THE REFERENCE
064D   DD5600           LD   D,(IX+GDR0)      ;GET CURRENT X
0650   DD5E01           LD   E,(IX+GDR1)      ;GET CURRENT Y
0653   CDED01           CALL FETCH            ;GET DATA
0656   CB59             BIT  3,C              ;TEST FOR LONG
0658   2036             JR   NZ,VEC3          ;JUMP IF LONG
065A   CB51             BIT  2,C              ;TEST FOR ABSOLUTE
065C   2022             JR   NZ,VEC2          ;JUMP IF ABSOLUTE
065E   F5               PUSH AF               ;SAVE DATA
065F   CB2F             SRA  A                ;SHIFT OVER
0661   CB2F             SRA  A                ;    FOUR PLACES
0663   CB2F             SRA  A                ;    TO MASK ALL BUT
0665   CB2F             SRA  A                ;    X OFFSET
0667   CB5F             BIT  3,A              ;TEST SIGN
0669   2804             JR   Z,VEC0           ;JUMP IF POSITIVE
066B   CB9F             RES  3,A              ;CLEAR SIGN
066D   ED44             NEG                   ;NEGATE
066F   82       VEC0:   ADD  A,D              ;ADD THE OFFSET
0670   57               LD   D,A              ;SAVE NEW X
0671   F1               POP  AF               ;RESTORE A
0672   E60F             AND  00001111B        ;MASK ALL BUT Y OFFSET
0674   CB5F             BIT  3,A              ;TEST SIGN
0676   2804             JR   Z,VEC1           ;JUMP IF POSITIVE
0678   CB9F             RES  3,A              ;CLEAR SIGN BIT
067A   ED44             NEG                   ;NEGATE
067C   83       VEC1:   ADD  A,E              ;ADD OFFSET
067D   5F               LD   E,A              ;SAVE NEW VALUE
067E   1832             JR   VEC7             ;JUMP
0680   F5       VEC2:   PUSH AF               ;SAVE A
0681   CB3F             SRL  A                ;SHIFT OVER
0683   CB3F             SRL  A                ;    FOUR PLACES
0685   CB3F             SRL  A                ;    TO MASK ALL BUT
0687   CB3F             SRL  A                ;    X VALUE
0689   57               LD   D,A              ;SET NEW VALUE
068A   F1               POP  AF               ;RESTORE A
068B   E60F             AND  00001111B        ;MASK ALL BUT Y VALUE
068D   5F               LD   E,A              ;SET NEW VALUE
068E   1822             JR   VEC7             ;JUMP
```

Listing 1 continued on page 338

Listing 1 continued:

```
0690   CB51               VEC3:   BIT   2,C            ;TEST FOR ABSOLUTE
0692   2019                       JR    NZ,VEC6        ;JUMP IF SO
0694   CB7F                       BIT   7,A            ;TEST SIGN
0696   2804                       JR    Z,VEC4         ;JUMP IF POSITIVE
0698   CBBF                       RES   7,A            ;CLEAR SIGN
069A   ED44                       NEG                  ;NEGATE
069C   82                 VEC4:   ADD   A,D            ;ADD OFFSET
069D   57                         LD    D,A            ;SAVE NEW VALUE
069E   CDED01                     CALL  FETCH          ;GET NEW VALUE
06A1   CB7F                       BIT   7,A            ;TEST SIGN
06A3   2804                       JR    Z,VEC5         ;JUMP IF POSITIVE
06A5   CBBF                       RES   7,A            ;CLEAR SIGN
06A7   ED44                       NEG                  ;NEGATE
06A9   83                 VEC5:   ADD   A,E            ;ADD OFFSET
06AA   5F                         LD    E,A            ;SAVE NEW VALUE
06AB   1805                       JR    VEC7           ;JUMP
06AD   57                 VEC6:   LD    D,A            ;SAVE NEW VALUE
06AE   CDED01                     CALL  FETCH          ;GET NEW VALUE
06B1   5F                         LD    E,A            ;SAVE NEW VALUE
06B2   CB49               VEC7:   BIT   1,C            ;TEST COLOR
06B4   2005                       JR    NZ,VEC8        ;JUMP IF SECONDARY
06B6   DD7E02                     LD    A,(IX+GDR2)    ;LOAD PRIMARY COLOR
06B9   1803                       JR    VEC9           ;JUMP AROUND
06BB   DD7E03             VEC8:   LD    A,(IX+GDR3)    ;LOAD SECONDARY COLOR
06BE   DD7749             VEC9:   LD    (IX+COLOR),A   ;SAVE THE COLOR
06C1   0E00                       LD    C,0            ;CLEAR THE COUNTER
06C3   E5                         PUSH  HL             ;SAVE H AND L
06C4   C5                         PUSH  BC             ;SAVE B AND C
06C5   6A                         LD    L,D            ;GET X ENDPOINT
06C6   2600                       LD    H,0            ;CLEAR H
06C8   DD4E00                     LD    C,(IX+GDR0)    ;GET X
06CB   0600                       LD    B,0            ;CLEAR B
06CD   AF                         XOR   A              ;CLEAR CARRY
06CE   ED42                       SBC   HL,BC          ;SUBTRACT
06D0   FAD906                     JP    M,VEC10        ;JUMP IF BORROW
06D3   DD364701                   LD    (IX+SX),1      ;SET SIGN OF X 1
06D7   1808                       JR    VEC11          ;JUMP AROUND
06D9   DD3647FF           VEC10:  LD    (IX+SX),-1     ;SET SIGN OF X -1
06DD   7D                         LD    A,L            ;GET THE DIFFERENCE
06DE   ED44                       NEG                  ;GET ABSOLUTE VALUE
06E0   6F                         LD    L,A            ;RESTORE THE DIFFERENCE
06E1   55                 VEC11:  LD    D,L            ;SAVE DELTA X
06E2   6B                         LD    L,E            ;GET Y
06E3   2600                       LD    H,0            ;CLEAR H
06E5   DD4E01                     LD    C,(IX+GDR1)    ;GET Y
06E8   0600                       LD    B,0            ;CLEAR B
06EA   AF                         XOR   A              ;CLEAR THE CARRY
06EB   ED42                       SBC   HL,BC          ;SUBTRACT
06ED   FAF606                     JP    M,VEC12        ;JUMP IF BORROW
06F0   DD364801                   LD    (IX+SY),1      ;LOAD+1
06F4   1808                       JR    VEC13          ;JUMP AROUND
06F6   DD3648FF           VEC12:  LD    (IX+SY),-1     ;LOAD -1
06FA   7D                         LD    A,L            ;GET THE DIFFERENCE
06FB   ED44                       NEG                  ;NEGATE THE DELTA
06FD   6F                         LD    L,A            ;RESTORE THE DIFFERENCE
06FE   5D                 VEC13:  LD    E,L            ;SAVE DELTA Y
06FF   6B                         LD    L,E            ;RESTORE DELTA Y
0700   2600                       LD    H,0            ;CLEAR H
0702   4A                         LD    C,D            ;GET DELTA X
0703   0600                       LD    B,0            ;CLEAR B
0705   AF                         XOR   A              ;CLEAR CARRY
0706   ED42                       SBC   HL,BC          ;SUBTRACT
0708   FA1307                     JP    M,VEC14        ;JUMP IF BORROW
070B   DD7345                     LD    (IX+MM),E      ;LOAD Y
070E   DD7246                     LD    (IX+MN),D      ;LOAD X
```

Listing 1 continued:

```
0711   1806                JR    VEC15              ;JUMP AROUND
0713   DD7245      VEC14:  LD    (IX+MM),D          ;LOAD X
0716   DD7346              LD    (IX+MN),E          ;LOAD Y
0719   DD7E45      VEC15:  LD    A,(IX+MM)          ;GET MM
071C   CB3F                SRL   A                  ;DIVIDE BY 2
071E   DD7744              LD    (IX+M),A           ;SAVE IT
0721   C1                  POP   BC                 ;RESTORE B AND C
0722   E1                  POP   HL                 ;RESTORE H AND L
0723   CDA007              CALL  CASE               ;GET THE CURRENT CASE
0726   DD7E49      VEC16:  LD    A,(IX+COLOR)       ;GET THE COLOR
0729   C5                  PUSH  BC                 ;SAVE BC
072A   D5                  PUSH  DE                 ;SAVE DE
072B   E5                  PUSH  HL                 ;SAVE HL
072C   CD3F0A              CALL  PLOT               ;PLOT THE POINT
072F   E1                  POP   HL                 ;RESTORE HL
0730   D1                  POP   DE                 ;RESTORE DE
0731   C1                  POP   BC                 ;RESTORE BC
0732   DD7E45              LD    A,(IX+MM)          ;GET MM
0735   B9                  CP    C                  ;COMPARE MM
0736   2001                JR    NZ,VEC17           ;JUMP IF NOT SAME
0738   C9                  RET                      ;RETURN
0739   E5          VEC17:  PUSH  HL                 ;SAVE H AND L
073A   C5                  PUSH  BC                 ;SAVE B AND C
073B   DD6E44              LD    L,(IX+M)           ;GET M
073E   2600                LD    H,0                ;CLEAR H
0740   DD4E46              LD    C,(IX+MN)          ;GET MN
0743   0600                LD    B,0                ;CLEAR B
0745   09                  ADD   HL,BC              ;ADD M+MN
0746   DD4E45              LD    C,(IX+MM)          ;GET MM
0749   0600                LD    B,0                ;CLEAR B
074B   AF                  XOR   A                  ;CLEAR CARRY
074C   ED42                SBC   HL,BC              ;SUBTRACT
074E   FA5E07              JP    M,VEC18            ;JUMP IF MINUS
0751   DD7544              LD    (IX+M),L           ;SAVE M
0754   C1                  POP   BC                 ;RESTORE B AND C
0755   E1                  POP   HL                 ;RESTORE H AND L
0756   DD6E48              LD    L,(IX+SY)          ;GET INC Y
0759   DD6647              LD    H,(IX+SX)          ;GET INC X
075C   1819                JR    VEC20              ;JUMP
075E   09          VEC18:  ADD   HL,BC              ;RESTORE M
075F   DD7544              LD    (IX+M),L           ;SAVE M
0762   C1                  POP   BC                 ;RESTORE B AND C
0763   E1                  POP   HL                 ;RESTORE H AND L
0764   2E00                LD    L,0                ;CLEAR L
0766   2600                LD    H,0                ;CLEAR POINTER
0768   DD7E45              LD    A,(IX+MM)          ;GET MM
076B   BA                  CP    D                  ;COMPARE WITH DELTA X
076C   2003                JR    NZ,VEC19           ;JUMP IF NOT EQUAL
076E   DD6647              LD    H,(IX+SX)          ;SAVE VALUE
0771   BB          VEC19:  CP    E                  ;COMPARE WITH DELTA Y
0772   2003                JR    NZ,VEC20           ;JUMP IF NOT EQUAL
0774   DD6E48              LD    L,(IX+SY)          ;LOAD SY
0777   DD7E00      VEC20:  LD    A,(IX+GDR0)        ;GET X
077A   84                  ADD   A,H                ;ADD INCREMENT
077B   DD7700              LD    (IX+GDR0),A        ;RESTORE X
077E   DD7E01              LD    A,(IX+GDR1)        ;GET Y
0781   85                  ADD   A,L                ;ADD INCREMENT
0782   DD7701              LD    (IX+GDR1),A        ;RESTORE Y
0785   0C                  INC   C                  ;INCREMENT COUNT
0786   189E                JR    VEC16              ;JUMP AROUND
                   ;
                   ; WAIT *************************************************
                   ;
                   ; WAIT ALLOWS SYNCHRONIZATION WITH THE FRAME RATE BY
                   ; WAITING FOR A SPECIFIED NUMBER OF FRAMES. WAIT FIRST
```

Listing 1 continued on page 340

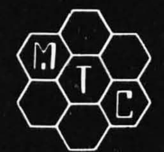
Listing 1 continued:

```
                ; GETS THE COUNT FROM EITHER THE PRIMITIVE ITSELF OR,
                ; IF THE EXTEND BIT IS ON, FROM THE NEXT BYTE. GDR4
                ; (FRAME COUNT) IS SET TO -COUNT AND WAIT THEN LOOPS
                ; UNTIL THE FRAME COUNT GOES TO ZERO.
                ;
                ; CALLS         FETCH
                ;
                ; CALLED BY     PRIMAT   (INDIRECTLY)
                ;
                ; REGISTERS     A        (PRIMITIVE OP CODE, TEMPORARY)
                ;               IX       (INDEX)
                ;
                ; I/O           NONE
                ;
                ; STRUCTURES    GDR4     (FRAME COUNT)
                ;
0788  CB5F      WAIT:   BIT  3,A                     ;TEST EXTEND BIT
078A  2805              JR   Z,WAIT0                 ;JUMP IF NOT SET
078C  CDED01            CALL FETCH                   ;GET COUNT
078F  1802              JR   WAIT1                   ;JUMP AROUND
0791  E607      WAIT0:  AND  00000111B               ;MASK ALL BUT COUNT
0793  ED44      WAIT1:  NEG                          ;NEGATE COUNT
0795  DD7704            LD   (IX+GDR4),A             ;SET FRAME COUNT
0798  DD7E04    WAIT2:  LD   A,(IX+GDR4)             ;GET COUNT
079B  FE00              CP   0                       ;TEST FOR ZERO
079D  20F9              JR   NZ,WAIT2                ;JUMP IF NON ZERO
079F  C9                RET                          ;RETURN
                ;
                ;***************************************************
                ;UTILITY SERVICE ROUTINES***************************
                ;***************************************************
                ;
                ; CASE *********************************************
                ;
                ; CASE DETERMINES THE CASE OF A REFERENCED VIEWPORT.
                ; IF A VIEWPORT IS NOT REFERENCED, CASE EXITS. OTHER-
                ; WISE, CASE IS SET IN REGISTER B.
                ;
                ; CALLS         NONE
                ;
                ; CALLED BY
                ;               LPIX
                ;               MOV
                ;               SYM
                ;               VEC
                ;               RPIX
                ;
                ; REGISTERS     A        (TEMPORARY)
                ;               B        (CASE)
                ;               D        (TEMPORARY)
                ;               E        (TEMPORARY)
                ;               H        (TEMPORARY)
                ;               L        (TEMPORARY)
                ;               IY       (INDEX)
                ;
                ; I/O           NONE
                ;
                ; STRUCTURES    GDR6-13 (VIEWPORTS)
                ;               REF      (REFERENCE)
                ;
07A0  F5        CASE:   PUSH AF                      ;SAVE AF
07A1  FDE5              PUSH IY                      ;SAVE IY
07A3  E5                PUSH HL                      ;SAVE H AND L
07A4  D5                PUSH DE                      ;SAVE D AND E
07A5  0600              LD   B,0                     ;ASSUME CASE 0
```

Listing 1 continued:

```
07A7  DDCB434E            BIT  1,(IX+REF)       ;TEST REFERENCE
07AB  2806                JR   Z,CASE0          ;JUMP IF NOT SET
07AD  D1                  POP  DE               ;RESTORE D AND E
07AE  E1                  POP  HL               ;RESTORE H AND L
07AF  FDE1                POP  IY               ;RESTORE STACK
07B1  F1                  POP  AF               ;RESTORE STACK
07B2  C9                  RET                   ;RETURN
07B3  FD218610    CASE0:  LD   IY,STRUCT+GDR6   ;LOAD REFERENCE START
07B7  DDCB4346            BIT  0,(IX+REF)       ;TEST REFERENCE
07BB  2804                JR   Z,CASE1          ;JUMP IF NOT SET
07BD  FD218A10            LD   IY,STRUCT+GDR10  ;LOAD REFERENCE START
07C1  FD6E02      CASE1:  LD   L,(IY+2)         ;LOAD RIGHT X
07C4  2600                LD   H,0              ;CLEAR H
07C6  CBC8                SET  1,B              ;SET BIT 1
07C8  FD5E00              LD   E,(IY+0)         ;GET LEFT X
07CB  1600                LD   D,0              ;CLEAR D
07CD  AF                  XOR  A                ;CLEAR CARRY
07CE  ED52                SBC  HL,DE            ;SUBTRACT
07D0  FAD507              JP   M,CASE2          ;JUMP IF MINUS
07D3  CB88                RES  1,B              ;RES BIT 1
07D5  FD6E03      CASE2:  LD   L,(IY+3)         ;GET RIGHT Y
07D8  2600                LD   H,0              ;CLEAR H
07DA  CBC0                SET  0,B              ;SET BIT 0
07DC  FD5E01              LD   E,(IY+1)         ;GET LEFT Y
07DF  1600                LD   D,0              ;CLEAR D
07E1  AF                  XOR  A                ;CLEAR CARRY
07E2  ED52                SBC  HL,DE            ;SUBTRACT
07E4  FAE907              JP   M,CASE3          ;JUMP IF MINUS
07E7  CB80                RES  0,B              ;RES BIT 0
07E9  D1          CASE3:  POP  DE               ;RESTORE D AND E
```

Listing 1 to be continued next month in Part 3



META TECHNOLOGIES

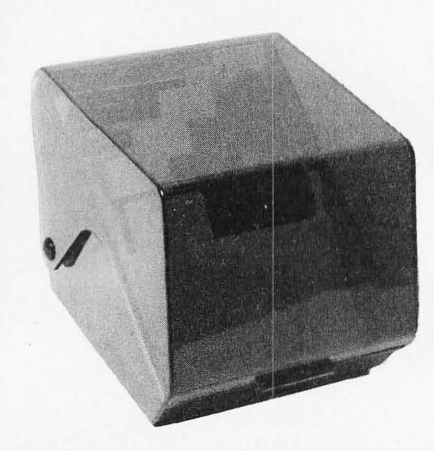


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PLASTIC LIBRARY CASES

(not shown)

An economical form of storage for 10 to 15 diskettes, and is suitable for your bookshelf! Case opens into a vertical holder for easy access.

5¼-inch diskette case $3.25
8-inch diskette case $3.50

Single Sided, Single Density, Soft-Sectored 5¼-inch, (for TRS-80™) Mini-floppy

DISKETTES

$19.80★ box of 10

Meta Technologies strikes again . . . at the competition! These are factory fresh, absolutely first quality (no seconds!) mini-floppies. They are complete with envelopes, labels and write-protect tabs in a shrink-wrapped box.

INTRODUCING

PLAIN JANE™

DISKETTES

The Beautiful Floppy
with the Magnetic Personality™

In 1980 alone, MTC has sold nearly a third of a million dollars worth of brand-name diskettes. If anyone knows quality, we do. And these are quality diskettes. The catch? They are in a plain white box. You're not paying for fancy printing, fancy labels or fancy names on the packaging. We don't even put our own label on the package (labels cost money). At this introductory price (our regular price will be $21.95 per box of 10) we cannot offer quantity or dealer discounts.

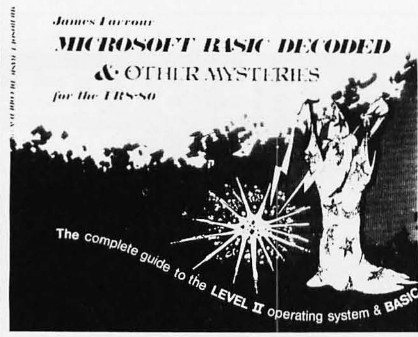
PLAIN JANE™ Diskettes . . . . . . $19.80★

VERBATIM brand Diskettes (box of 10)

5¼-inch (for TRS-80™)
MD525-01 . . . . $23.95
10 boxes of 10 . . . (each box) . . . $22.95

8-inch FLOPPIES
Single-Density, FD34-1000 . . . $29.95
Double-Density, FD34-8000 . . $39.95

TRS-80™ PRODUCTS



NEWDOS/80 by Apparat $149.95
NEWDOS+ with ALL UTILITIES
35-track $69.95
40-track $79.95
TRS-80™ DISK AND OTHER MYSTERIES . . . $19.95
MICROSOFT ™ BASIC DECODED & OTHER MYSTERIES for the TRS-80™ $29.95

META TECHNOLOGIES REDEFINES "Customer Satisfaction" IN 1981

met-a-mor-pho-sis (met′ə môr′ fə sis), *n.*, *pl.* -ses(-sēz′). 1. a transformation. 2. a change or successive changes in character or appearance. 3. MTC's transition in 1981 to a bigger and better way of doing business, featuring new and improved products and services.

CALL FOR INFORMATION ON OTHER TRS-80™ PRODUCTS

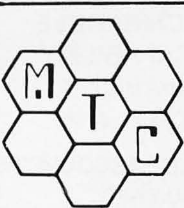
All products guaranteed for replacement only. Prices, Specifications & Offerings subject to change without notice.

MOST ORDERS SHIPPED WITHIN ONE BUSINESS DAY

★PRICE GOOD THRU DECEMBER 31, 1980. Sorry, no dealer or quantity discounts. Allow for possible shipping delays.

WE ACCEPT
- VISA
- MASTER CHARGE
- CHECKS
- MONEY ORDERS
- C.O.D.

- Add $2.50 for standard UPS shipping & handling
- $2.00 EXTRA for C.O.D.
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TO PLACE ORDER 1-800-321-3552 — CALL TOLL FREE — FOR PRODUCT INFO 1-800-321-3640

IN OHIO (216)289-7500 (COLLECT)



META TECHNOLOGIES CORPORATION

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PLAIN JANE is a TM of MTC.
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Circle 356 on inquiry card.

What's New?

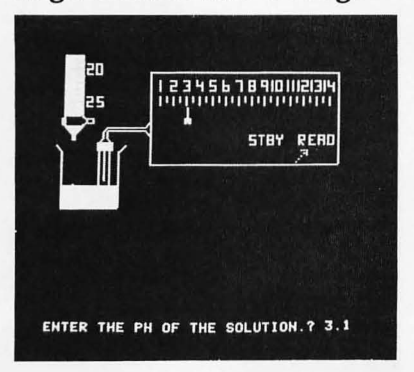
SOFTWARE

Commercial Mailer Has 30,000 Name Capacity

Commercial Mailer, from Stonehenge Computer Company, 89 Summit Ave, Summit NJ 07901, (201) 277-1020, has a capacity of up to 30,000 six-line records, with an unlimited number of lists. This program offers features including creating, adding, changing, deleting, sorting, utility/field code, and more. Required hardware includes the Apple II with 48 K bytes of memory, the Corvus 11AP Hard Disk, and an 80- or 132-column printer. Optional hardware are the Corvus Constellation and Corvus Mirror. The format is a menu type, and the system can be adapted to the user's format. The price is $250, plus $3 for shipping.

Circle 404 on inquiry card.

Chemistry Programs for High School and College



Chemistry Lab Simulation 1 and 2 are for use on the Apple II computer. The programs may be used either as an aid in lecture presentations or for individual study. Chemistry Lab 1 uses graphics to simulate introductory-level chemistry experiments, including acid-base titration; a monomolecular film experiment used for the determination of Avogadro's number; and finding an unknown weak acid by determining its equilibrium constant. The program provides randomly generated initial values, giving unlimited test results without repetition. Chemistry Lab 2 illustrates the behavior of gas particles as the user varies the gas environment. Students are guided through the Ideal Gas Law, the Kinetic-Molecular Theory, and the principles of entropy. The program features low-resolution graphics and is written in machine language. For details, contact High Technology Inc, Software Department, POB 14665, Oklahoma City OK 73113, (405) 840-9900.

Circle 409 on inquiry card.

Traffic Program for Radio Stations

The Electric Log is designed for the TRS-80 Model II personal computer. The program stores up to 500 time-spot schedules and automatically generates daily program logs with date checking, product code separation, account separation, and, optionally, random tray location for automation. The Electric Bill ties into the Electric Log to provide a standard accounts receivable and statement printer. For additional information, contact, The Management, POB 111, Aledo TX, (817) 441-8045.

Circle 405 on inquiry card.

Lowercase Driver Plus

Lowercase Driver Plus is an advanced driver routine to work with the lowercase modification kit sold by E B G (Emmanuel B Garcia Jr) & Associates. With this routine and the lowercase modification in the TRS-80, users will be able to display lowercase at all times. The keyboard then will work as a regular typewriter (ie: shifted characters will be uppercase, and unshifted characters will be lowercase). Provision has also been made for a CAPS LOCK function. An automatic repeat action that can be obtained by holding any key down for a few seconds is included. Lowercase Driver Plus will also work with most other lowercase modifications. The price is $9.95, from E B G & Associates, 203 N Wabash, Chicago IL 60601, (312) 782-9750.

Circle 406 on inquiry card.

Computer War Games

The Avalon Hill Game Company, 4517 Harford Rd, Baltimore MD 21214, (301) 254-5300, presents *B-1 Nuclear Bomber*, *Midway Campaign*, *North Atlantic Convoy Raider*, *Nukewar*, and *Planet Miners*. These games run on TRS-80 Model II, Apple II, and PET microcomputers. They cost $15 each.

Circle 407 on inquiry card.

MED-PAC II

The MED-PAC II (Medical Patient Accounting System) is a medical accounting system that features billing, recording of charges, adjustments and payments, automatic printing of insurance forms, instantaneous recall of patient records and account status, increased collections and reduced aging, analysis of services performed by each producer in the practice, and the ability to run with the accounts payable, payroll, and general ledger programs from V R Data Corporation. The company also has a Med Pac System that includes a high-resolution monitor and ASCII (American Standard Code for Information Interchange) keyboard, a 64 K-byte memory board with a Z80 microprocessor, 1 megabyte of disk storage, a letter-quality printer, manuals, on-site training lessons, and medical software. The cost of the system is $14,249. Contact Small Systems Group, 777 Henderson Blvd N-6, Folcroft Industrial Park, Folcroft PA 19032, (800) 345-8102.

Circle 408 on inquiry card.

L216—Business Software Package

L216 is a business package for the TRS-80 Model II with 16 K bytes of memory and Level II BASIC. A cassette data-base manager, word processor, inventory-control system, stock-management program, check-balancing program, label printer, deposit calculator, statistics program, sort utility, and a key-access utility are included. The package is priced at $59. For information, contact Micro Architect Inc, 96 Dothan St, Arlington MA 02174, (617) 643-4713.

Circle 410 on inquiry card.

Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

What's New?

SOFTWARE

Word Processing for the Apple II

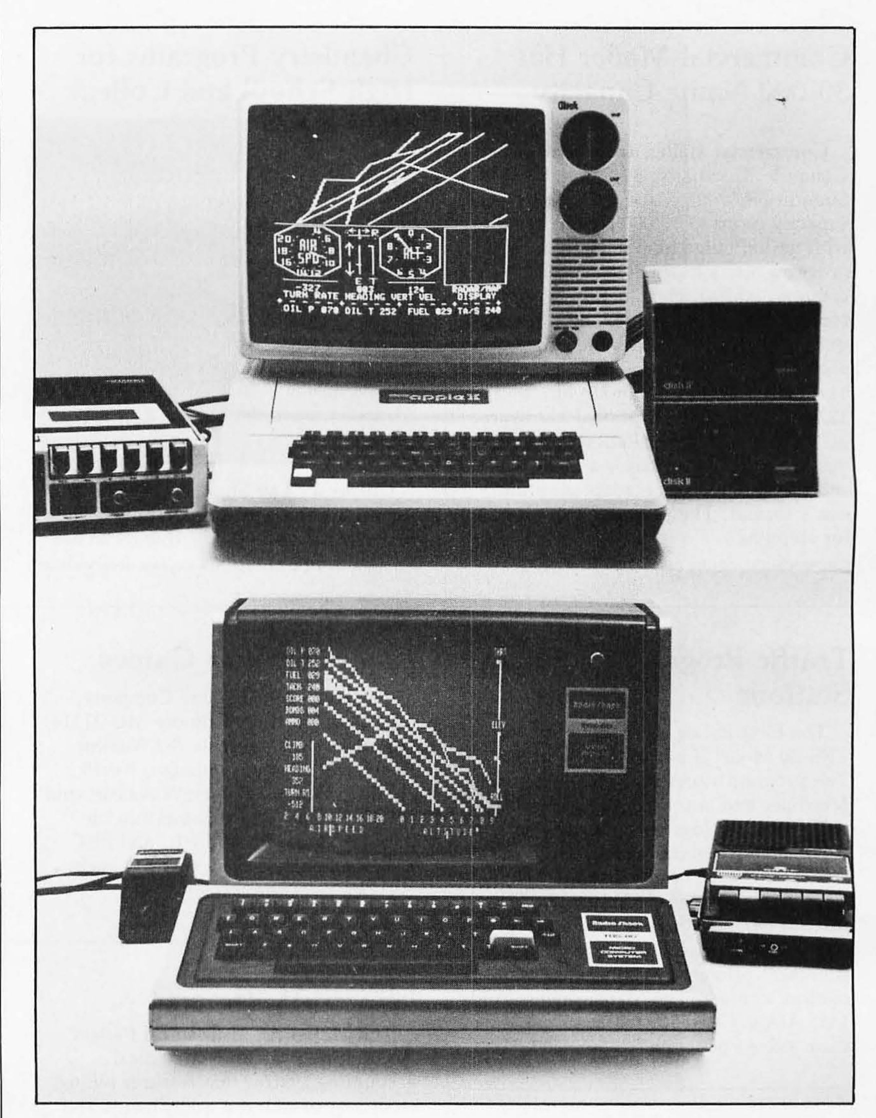
A word-processing program called the Datacope Scribe is available for the Apple II. On-screen editing is by character, word, sentence, and paragraph, plus block insert, block move, and block delete. General formats control the locations and justification of margins, tab locations, and the number of lines per page and their spacing. Special formats may be used to center, indent, and underline text. The program can print single or multiple copies without user intervention. Single-letter commands are included. Memory can hold approximately eleven pages of text. A BASIC program allows users to customize the machine-language program to match the user's printer, printer interface, and personal preferences. Minimum equipment requirements are an Apple II with 48 K bytes of memory, Applesoft in ROM (read-only memory), an Apple II Plus with 48 K bytes of memory, or an Apple Language System; Dan Paymar's Lower Case Adapter; a Disk II drive; and a printer and printer interface. The suggested retail price for the Datacope Scribe is $79.95. Contact Datacope, PO Drawer AA, Hillcrest Sta, Little Rock AR 72205.

Circle 400 on inquiry card.

CP/NET Operating System from Digital Research

Digital Research Inc, originator of the CP/M and MP/M operating systems, has introduced CP/NET, a new operating system for microcomputer networks. The CP/NET software system supports network technology by allowing independent microcomputers access to common facilities, such as peripherals, programs, and data bases, via a network. CP/NET operates with CP/M and MP/M. Applications range from multiterminal word-processing and/or data-base systems that share disks and printers to industrial process-control systems that use single-board computers, without disk or console facilities, as slaves. CP/NET consists of one or more masters running MP/M and one or more slaves running CP/M or MP/M. CP/NET is network independent. Through simple modifications, a network may be constructed with any combination of shared memory, serial links or parallel I/O (input/output) with any protocol. For more information, contact Digital Research Inc, POB 579, Pacific Grove CA 93950, (408) 649-3896.

Circle 401 on inquiry card.



Flight Simulators for TRS-80 and Apple Systems

The A2-FS1 for the Apple II, and the T80-FS1 for the TRS-80, are visual flight simulators that offer a real-time three-dimensional out-the-window view of flight. The view updates at an average of three times per second. The animation and flight characteristics allow the non-pilot to learn basic flight control. The FS1 instrument panel contains all the instruments required under part 91 of the Federal Aviation Regulations for visual flight. The FS1 includes a stall warning, turn indicator, radar screen, ammunition indicator, and control position indicators. Controls include throttle, brakes, bomb drop, machine guns, high/low world, and declare war. The T80 features a downward map selector. The A2 includes a keyboard/paddle selector. The FS1 requires 16 K bytes of memory. The programs cost $25. The A2 is available on disk for $33.50. Contact SubLOGIC, POB V, Savoy IL 61874, (217) 359-8482.

Circle 403 on inquiry card.

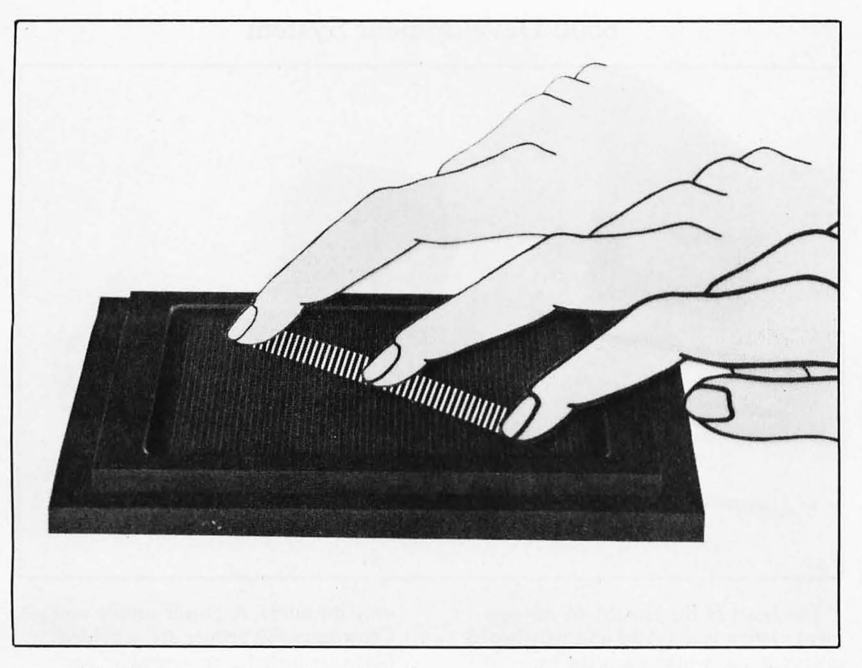
Graphics for the Apple

United Software of America has a three-dimensional high-resolution graphics package for the Apple II called Apple World, which is a text-editor-based color graphics package. The program comes with a manual and requires any Apple II or Apple II Plus with 48 K bytes of programmable memory and a floppy-disk drive. It is written in machine code. The price is $59.95 from United Software of America, 750 Third Ave, New York NY 10017, (212) 682-0347.

Circle 402 on inquiry card.

What's New?

MISCELLANEOUS



X,Y Positioning Device Operates by Fingertip Glide

TASA (Touch Activated Switch Arrays Inc) has introduced this alternative for trackballs and other two-dimensional controllers that provide coarse and fine position adjustment by changing fingertip speed. The X,Y controller produces X,Y positioning signals when a finger is moved across its surface. It can be interfaced with plotters, video displays and other devices. The unit uses 70% less space than trackballs, has no moving parts, and is environmentally sealed. The 10.2 by 10.2 cm (4 by 4 inch) surface can be traversed at up to 60 inches per second without loss of resolution. Rapid finger movement can give coarse control; slow movement offers fine control. The Model 4460 X,Y Positioner is priced under $500 in OEM (original equipment manufacturer) quantities. For information, contact TASA Inc, 2346 Walsh Ave, Santa Clara CA 95051, (408) 727-8272.

Circle 412 on inquiry card.

MC68000 Development Boards Extend EXORmacs Systems

Motorola has introduced four MC68000 modules for use with the EXORmacs system. The User System Emulator (USE) provides the connection between the user's nondebugged hardware/software system and the diagnostic power within the EXORmacs itself. The extension provides the debug functions of MACSbug and the symbolic debugger SYMbug, along with the file-management and memory-storage capability of EXORmacs. USE consists of the USE Control Module, Buffer Box, and interface cable. The price is $1500. The VERSAbus dynamic-memory modules include a special addressing for placement of memory in both the system and the user's map throughout the 16-megabyte range of the MC68000 microprocessor. A parity feature is provided. Prices for 32 K- to 128 K-byte memory modules range from $1400 to $3500. The VERSAbus Adapter Module board plugs into EXORmacs bus slots and provides an interface between the 8-bit EXORbus modules and the 16-bit VERSAbus. The modules also provide user-selectable interrupt levels and controls required by the VERSAbus interrupt scheme. The price is $295. For more information on these and other EXORmacs products, contact Motorola Semiconductor Products Inc, POB 20912, Phoenix AZ 85036, (602) 962-2209.

Circle 413 on inquiry card.

ASCII Encoded Keyboard Kit

The JE610 ASCII (American Standard Code for Information Interchange) Encoded Keyboard kit comes with a sixty-two-key keyboard switch assembly, integrated circuits, sockets, connector, electronic components, and a double-sided printed-circuit board. Wiring instructions and circuit diagrams are included. The full 128-character ASCII set can be generated. Two user-defined keys are provided, as is a caps lock for uppercase. The keyboard assembly requires +5 VDC at 150 mA and -12 VDC at 10 mA for operation. Interfacing is accomplished by an integrated circuit or an eighteen-pin edge card connector. The suggested retail price is $79.95. The DTE-AK enclosure is available for $49.95. Contact Jameco Electronics, 1355 Shoreway Rd, Belmont CA 94002, (415) 592-8097.

Circle 414 on inquiry card.

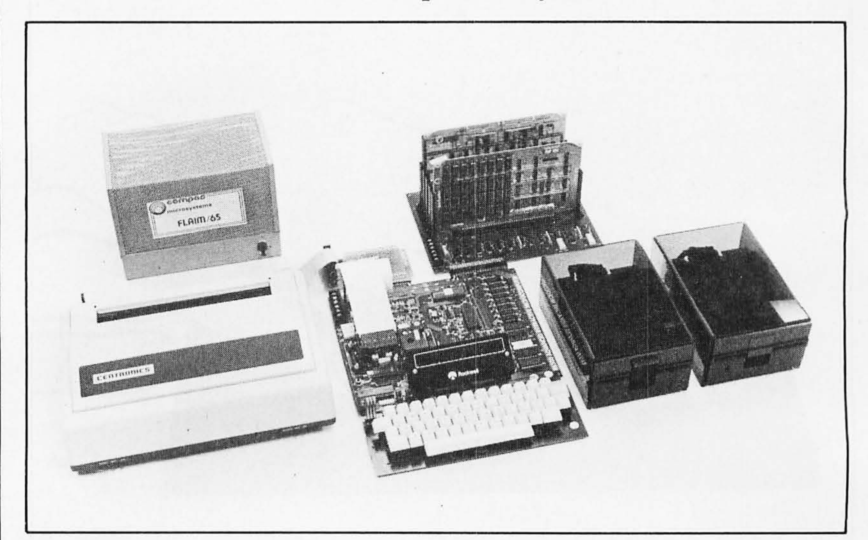


Three New Computers from Radio Shack

The TRS-80 Model III is available in several configurations, and it ranges in price from $699 for the 4 K-byte version (expandable to 32 K bytes) to $2495 for units with 313 K bytes of disk storage. It is compatible with Model I TRS-80s and features Model III BASIC. Features included are: uppercase and lowercase on the video display, a printer interface, the capability to add two double-density floppy-disk drives, and more. The TRS-80 Pocket Computer weighs 6 ounces and is less than 7 inches long. It is able to do most of the smaller jobs the TRS-80 Model I computer can do. The Pocket Computer features power-off retention of programs and data. The resident BASIC includes multiple statements, mathematics functions, editing, strings, arrays, and more. The price is $249. The TRS-80 Color Computer provides color graphics and features Program Pak software that enables the user to set up the computer for a variety of educational and recreational purposes. It features a television modulator, provides high-resolution modes, and can be expanded to 16 K bytes of memory. The price is $399. For more information, contact Radio Shack, 1800 One Tandy Center, Ft Worth TX 76102, (817) 390-3272, or visit your local participating Radio Shack dealer.

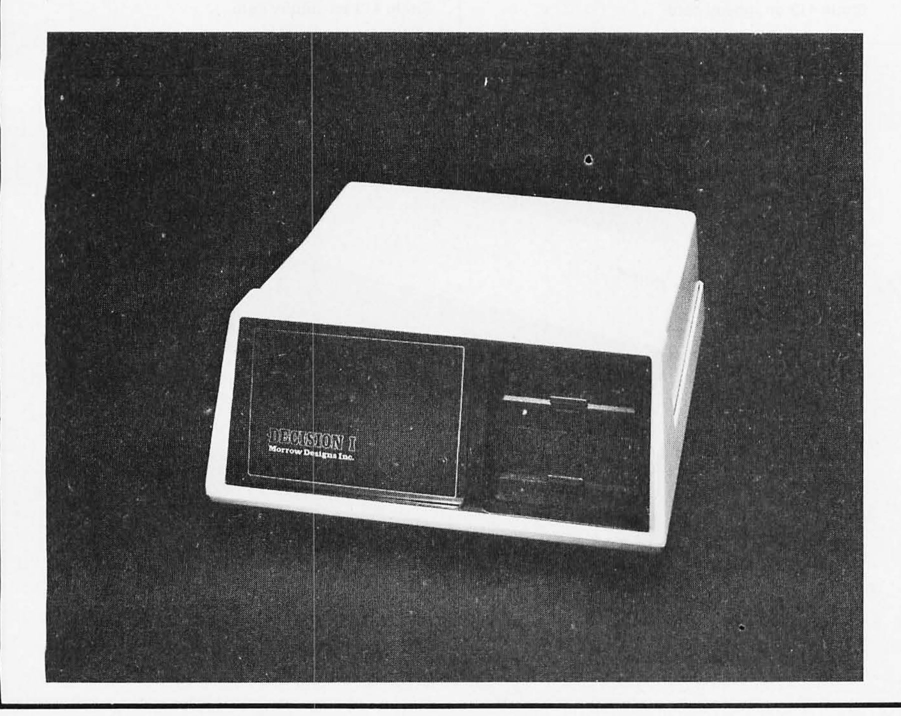
Circle 415 on inquiry card.

6500 Development System



The heart of the FLAIM/65 development system is the AIM-65 single-board microcomputer manufactured by Rockwell International. The AIM-65 provides a 20-character alphanumeric display, thermal printer, and a keyboard. An expansion motherboard provides five card slots compatible with the Motorola EXORcisor bus. Dual 5-inch floppy-disk drives provide 160 K bytes of programmable-memory storage. The disk operating system is contained in EPROM (erasable programmable read-only memory). A power supply and a Centronics 730 printer are provided. Software includes an assembler and compiler. PL/65, built in to ROM (read-only memory), is a systems language designed specifically for the 6500 family. A complete FLAIM/65 system is priced at $3705 from Compas Microsystems, 224 SE 16th St, Ames IA 50010, (515) 232-8187.

Circle 416 on inquiry card.



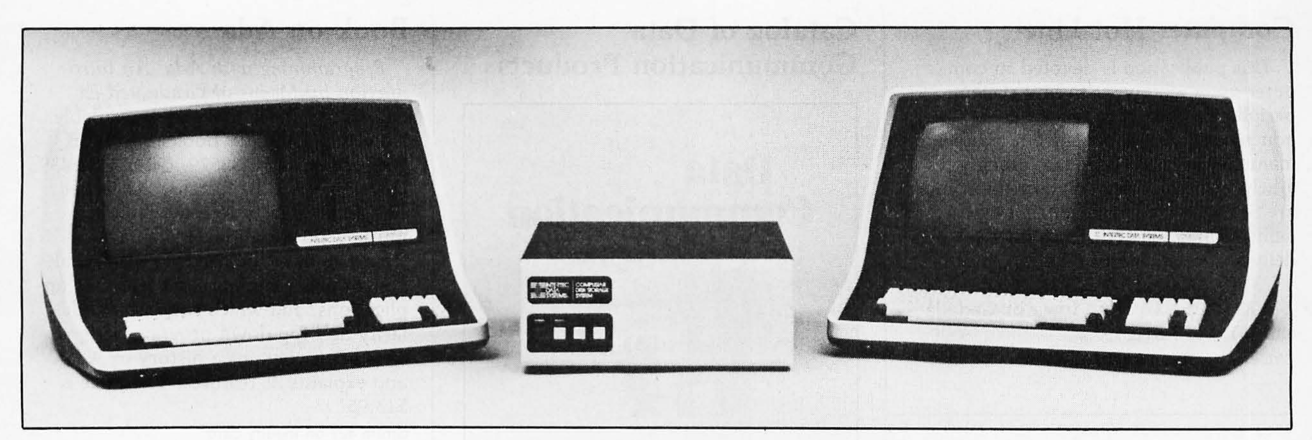
The Decision 1 Microcomputer

Morrow Designs, 5221 Central Ave, Richmond CA 94804, (415) 524-2101, has announced the Decision 1, a multitasking, IEEE (Institute of Electrical and Electronics Engineers) standard S-100 bus microcomputer that costs under $5000 in a four-user configuration. The machine is designed for the word-processing and the business data-processing industries. The computer features a Z80 microprocessor, a UNIX-compatible operating system that runs CP/M as a subsystem, and business-applications and word-processing packages. The memory-management hardware includes a memory map that supports up to sixteen tasks without swapping. The system can support dual 800 K-byte 5-inch floppy-disk drives, dual 1.2-megabyte 8-inch drives, and a 26-megabyte Winchester hard disk.

Circle 417 on inquiry card.

What's New?

SYSTEMS



Multi-User Microcomputer System

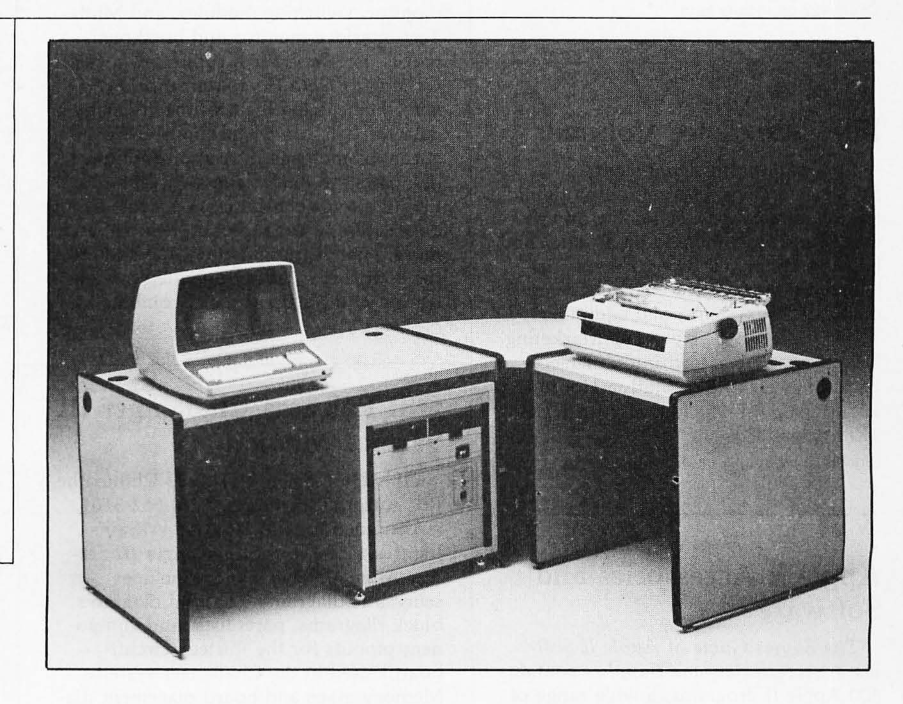
The CompuStar Multi-User system consists of a network of video-display terminals which employ individual microprocessors and dynamic programmable memory. The terminals are tied together in a network fashion to share the resources of a single Winchester or other hard-disk device. The system shares disk drives while allowing individual users the capability to maintain restricted data bases. The system architecture is based around one of three disk storage systems. A 10-megabyte Shugart-type Winchester 8-inch drive is offered for $3995. Also offered as disk storage options are a 32- or 96-megabyte cartridge module drive. The 32-megabyte model is $11,995; the 96-megabyte model is $14,995. The multi-user systems can accept up to 255 video terminals in a single network. Each terminal, manufactured by Intertec, has twin RS-232 serial ports for printers and other peripherals. Video terminals range in price from $2495 for a 12-inch, 64 K-byte unit, to a dual double-sided, double-density floppy-disk drive, 12-inch unit that can store 1.5 megabytes of data. This terminal costs $4995. One of the basic units, allowing printer interfacing, costs $1995. For more information on the CompuStar System, contact Intertec Data Systems, 2300 Broad River Rd, Columbia SC 29210, (803) 798-9100.

Circle 418 on inquiry card.

Mercator Microcomputer

The MBS 4000 uses a 16-bit microprocessor, and the system bus is compatible with the Intel Multibus. The basic configuration includes an 8-inch Winchester disk drive and tape cartridge backup. The minimum memory configuration provides 128 K bytes of programmable memory (expandable to 256 K), with error checking and correcting logic, and 4 K bytes of PROM (programmable read-only memory). The system includes a 400 W switching power supply. Eight serial RS-232 ports and a parallel printer port are included. A disk-expansion port and a Multibus expansion port are optional. Contact Mercator Business Systems, 2378A Walsh Ave, Santa Clara CA 95051, (408) 496-0424.

Circle 419 on inquiry card.



Business Systems from CMC

CMC Marketing Corporation, 10611 Harwin, Suite 406, Houston TX 77036, (713) 995-4960, has introduced a line of computer systems for small and large businesses and for word-processing applications. These systems are built around the Z80A microprocessor and feature the S-100 bus. Systems can be configured with floppy-disk storage of up to 4 megabytes and hard-disk storage of up to 28 megabytes. All systems can utilize the CP/M operating system. The word-processing systems, as well as the other systems, use the Magic Wand word-processing program, with an NEC Spinwriter printer. The System 100 series for small businesses offers RS-232 and parallel ports for use with a variety of printers and peripherals. Microsoft BASIC is built in. The System 200 series can support up to eight work stations. It uses the Shugart SA4000 Winchester hard disk with 14 to 28 megabytes of storage. For additional details, contact the company.

Circle 420 on inquiry card.

What's New?

PUBLICATIONS

Computer Hot Line

This publication is devoted to computer users who want to buy systems, peripherals and other related components. Advertisements from major manufacturers are included, along with a help wanted section. Subscription rates are $45.90 for one year of first class delivery and $28.60 for regular mail delivery. Contact Hot Line Inc, POB 1373, Fort Dodge IA 50501, (800) 247-2244, ext 27, from Iowa or Canada call (515) 573-8133.

Circle 421 on inquiry card.

Matrix Printer Brochure

A brochure describing microprocessor-controlled dot-matrix printers for general and special applications is available from Dataroyal Inc, 235 Main Dunstable Rd, Nashua NH 03061, (603) 883-4157. The brochure details the Dataroyal IPS 5000 series of matrix printers for use with small-business systems and the 7000 series capable of printing bar code and variable size labels.

Circle 422 on inquiry card.

IEE Conference Volume

Communications Equipment and Systems contains information on public telecommunications: switching and networks; transmission and data; data- and business-communications systems: intelligent terminals and emergency communications: systems; and equipment. The price is $41.50 from The Marketing Department , The Institution of Electrical Engineers (IEE), Station House, Nightingale Rd, Hitchin, Hertford, SG5 1RJ England.

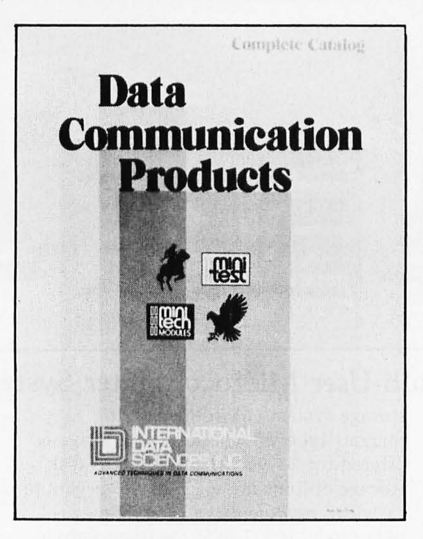
Circle 423 on inquiry card.

Apple II Accessories and Software

The Buyers Guide of Apple II Software, Accessories, and Supplies contains 500 Apple II programs, a wide range of accessories, supplies, and books. *The Buyers Guide* sells for $3 and a certificate worth $3 off the first purchase is supplied. Contact Wallace Computers, Accessories and Supplies Inc, 1024 W Willcox, Peoria IL 61604, (309) 685-7876.

Circle 424 on inquiry card.

Catalog of Data Communication Products



International Data Sciences Inc, 7 Wellington Rd, Lincoln RI 02865, (401) 333-6200, the manufacturer of Range Rider Modem/TDM Test Sets, Hawk 4000 Datatraps, MiniTech EIA (Electronic Industries Association) patch, monitor, switching modules, and Mini-Test interface monitor and breakout panels, is offering free copies of its 1980 *Catalog of Data Communication Products*. The catalog features the company's data test sets for synchronous and asynchronous modems, EIA and telephone line patch, monitor, and switching modules for technical control centers; data cables; error detection devices, and more. Also featured is the Model 65/60, the company's battery-operated modem test set and breakout panel combined.

Circle 425 on inquiry card.

OSI Releases Challenger III Service Manual

OSI (Ohio Scientific), 1333 Chillicothe Rd, Aurora OH 44202, (216) 562-3101, in conjunction with Howard W Sams Inc, has released the *Challenger III Service Manual*. This manual includes schematic diagrams, pictorial diagrams, block diagrams, parts lists, and component pinouts for the thirteen circuit boards used in the Challenger systems. Memory maps and board placement diagrams are also included. One important feature of the manual is the fold-outs which spread up to eight pages in width. This and other OSI manuals are available from Ohio Scientific dealers. For the name of your local dealer, call (800) 321-6850.

Circle 426 on inquiry card.

Book on Ada

Programming with Ada: An Introduction by Means of Graduated Examples, by Peter Wegner, is available from the Computer Bookstore, POB 556, Shalimar FL 32579, (904) 242-6439. Developed for the Defense Advanced Research Projects Agency, Ada is a multipurpose high-level language designed to meet the needs of numerical, system programming, and real-time applications, and which supports modularity and top-down program design. This book contains a history of Ada and explains its features. The price is $13.95.

Circle 427 on inquiry card.

Brochure Describes TABOL III a Business Language

TABOL III, a publication describing a new business language for building business analysis and reporting systems, is available from the General Electric News Bureau, 8150 Leesburg Pike, Suite 510, Vienna VA 22180, (202) 637-4557. This brochure discusses TABOL III and its applications involving the development, manipulation, and presentation of data in a tabular format. Applications concerning finance, manufacturing and sales, and marketing are also covered.

Circle 428 on inquiry card.

Books from Hayden

Hayden Book Company Inc, 50 Essex St, Rochelle Park NJ 07662, has introduced two books and two software programs. *Programmable Pocket Calculators* covers many of the Hewlett-Packard calculators and costs $8.95. *Microprocessor Software Design* is a compilation of articles from *Electronic Design* and is priced at $11.95.

The first program is an Apple assembly-language development system with an assembler, editor, and formatter for the Apple II disk system with 24 K bytes of memory. It costs $39.95. The second program is Blackjack Master: A Simulator/Tutor/Game for the TRS-80 computer. The 16 K version is $19.95 and the 32 K disk version is $24.95.

Circle 429 on inquiry card.

HOT WINTER PRICES ON PERSONAL COMPUTERS AND COMPONENTS.

Look at this!



Ohio Scientific Superboard II

$299

- It's the first complete computer system on a board.
- Superboard II uses the ultra powerful 6502 Microprocessor
- 8K Microsoft BASIC-in-ROM
- 4K static RAM on board, expandable to 8K
- Full 53-key keyboard, with upper and lower case. Plus user expandability.
- Video interface and audio cassette interface.

The Ohio Scientific Superboard II at $299 — in today's economy — has got to be the best buy by far. It will entertain you with spectacular graphics made possible by its ultra high resolution graphics and super fast BASIC. It will help you in school or industry, as an ultra powerful scientific calculator. Advanced scientific functions and a built-in "immediate" mode allow you to solve complex problems without programming.

The Superboard II can be expanded economically, for business uses, or to remotely control your home appliances and security. Even communicate with other computers.

Read what's been written about Superboard II:

"We heartily recommend Superboard II for the beginner who wants to get into microcomputers with a minimum cost. A real computer with full expandability."

—POPULAR ELECTRONICS, MARCH 1979

"The Superboard II is an excellent choice for the personal computer enthusiast on a budget."

—BYTE, MAY 1979

Look at these easy hardware prices:

610 Board For use with Superboard II and Challenger 1P. 8K static RAM. Expandable to 24K or 32K system total. Accepts up to two mini-floppy disk drives. Requires +5V @4.5 amps.	**$ 298**
Mini-Floppy Disk Drive Includes Ohio Scientific's PICO DOS software and connector cable. Compatible with 610 expander board. Requires +12V @1.5 amps and +5V @ 0.7 amps. [Power supply & cabinet not included.]	**299**
630 Board Contact us for important details.	**229**
AC-3P 12″ combination black and white TV/video monitor.	**159**
4KP 4K RAM chip set.	**79**
PS-005 5V 4.5 amp power supply for Superboard II.	**35**
PS-003 12V power supply for mini-floppies.	**29**
CS-600 Metal case for Superboard II, 610 and 630 board and two power supplies. [While stock lasts.]	**49**
CS-900B Metal case for single floppy disk drive and power supply. [While stock lasts.]	**49**
AC-12P Wireless remote control system. Includes control console, two lamp modules and two appliance modules, for use with 630 board.	**175**
AC-17P Home security system. Includes console, fire detector, window protection devices and door unit for use with 630 board.	**249**
C1P Sams C1P Service manual	**8**
C4P Sams C4P Service manual	**16**
C3 Sams Challenger III manual	**40**

Ohio Scientific and independent suppliers offer hundreds of programs for the Superboard II, in cassette and mini-floppy form.

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☐ Superboard II $299.
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☐ AC-3P 12″ B/W Monitor $159.
☐ C1P Sams Manual $8.

[Attach separate sheet for other items.]

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Orders of less than $100, please add $4.00 to cover shipping costs.
All orders shipped insured UPS unless otherwise requested. FOB Cleveland, Ohio.

Circle 272 on inquiry card.

What's New?

PUBLICATIONS

Queue Catalog

Queue's *Catalog #3* is a directory of educational software available for the Apple II, TRS-80, PET, and Atari computers. Programs from over forty educational software publishers are described and grouped together by computer, subject matter, and grade level. All the programs can be ordered through Queue. The catalog is $8.95 from Queue, 5 Chapel Hill Dr, Fairfield CT 06432.

Circle 430 on inquiry card.

Tool Kits, Cases, and Test Equipment

A catalog from Specialized Products Company, 2324 Shorecrest Dr, Dallas TX 75235, (214) 358-4663, features tools, test equipment, and cases from Fluke, Beckman, and other manufacturers. Contact the company for a copy.

Circle 431 on inquiry card.

CP/M Software Summary Guide

Rainbow Associates, POB 35, Glastonbury CT 06025, has published the *CP/M Software Summary Guide*, a guide to the major software systems used on most CP/M systems. Included are summaries of the CP/M operating system, Microsoft BASIC, CBASIC, and the CP/M utilities DESPOOL, MAC, and TEX. The CP/M summary covers system commands and utilities with explanations and examples. Error codes for CBASIC-1, CBASIC-2, and BASIC-E are summarized. Examples and definitions explain the utilities offered by Digital Research. The price is $3.75.

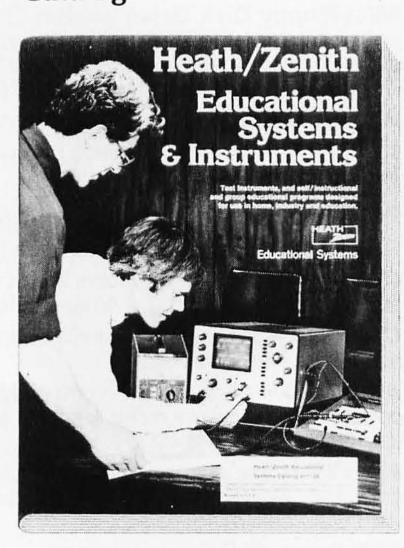
Circle 432 on inquiry card.

Math Guidebook

Calculator Calculus, by Professor George McCarty, details a system for learning and teaching mathematics through computation. Algorithms produce numerical examples for limit processes, differentiation, integration, and sums of series. Programs are suitable for hand-held calculators and larger systems. Numerical techniques such as Newton's method, Padé approximation, and Fourier series are included. The price is $14.95, from EduCALC Publications, Department BY, POB 974, Laguna Beach CA 92652, (714) 497-3600.

Circle 433 on inquiry card.

Systems and Instruments Catalog



A free catalog describing educational programs and test instruments for schools, industry, government, and self-instruction, has been published by the Heath Company, Benton Harbor MI 49022, (616) 982-3210. This edition has information on self- and group-instruction college-level programs in electronics, microprocessors, and computer programming. The catalog features product descriptions and specifications on test instruments. Programs listed in this catalog are offered by Heath/Zenith Educational Systems.

Circle 434 on inquiry card.

The Fifth Edition of the TRS-80 Software Directory

The fifth edition of the *TRS-80 Software Directory* is available from ComputerMat, POB 1644A, Lake Havasu AZ 86403, (602) 855-3357. This edition has over 7000 listings of Model I and II software, and includes the names and addresses of over 600 software suppliers. One section is devoted to Model II software for businesses, another to mathematics and utility programs. The catalog gives information on program titles, short descriptions, BASIC needed, memory required, class, cost, and the program medium. The price is $7 per issue in the US, which includes postage. Canadian and foreign orders are $9. Distributors and suppliers of TRS-80 software can be listed in the directory at no charge by sending ComputerMat their latest catalog.

Circle 435 on inquiry card.

Alpha Micro Business Systems

A brochure introducing Alpha Micro's business-computer systems is available. The systems are multitasking, multiuser, and time-sharing. Software includes languages such as AlphaBASIC and AlphaPascal, word-processing and text-formatting applications, and over 150 separate utility programs and subroutines, including utilities for sorting, spooling, and file handling. Contact Alpha Micro, 17881 Sky Park N, Irvine CA 92713, (714) 641-0386, for a copy of the brochure.

Circle 436 on inquiry card.

Universal Semiconductor Cross-Reference Guide

This cross-reference guide includes Zenith semiconductor devices that replace more than 158,000 currently used devices. The guide allows service technicians to use Zenith semiconductors in color and black and white televisions, stereo systems, radios, and personal and business computers. Contact Zenith Radio Corporation, 1000 Milwaukee Ave, Glenview IL 60025, (312) 391-8181.

Circle 437 on inquiry card.

CompuMart Catalog

CompuMart Corporation, POB 568, Department 333, Cambridge MA 02139, (617) 491-2700, has published a thirty-six-page catalog of microcomputers and peripherals. The catalog features Digital Equipment Corporation's LSI-11 hardware, Apple, Atari, Commodore, Heath, Exidy, and Texas Instruments systems and peripherals. Books on different aspects of microcomputers are also included in this catalog. The catalog can be obtained free of charge from the CompuMart Corporation.

Circle 438 on inquiry card.

BASIC Self-Teaching Guide from Radio Shack

TRS-80 Level II BASIC is a beginner's guide designed for users who have not had previous experience with computers. Short games, application programs, and the elements of developing simulation routines are presented. The book is available from participating Radio Shack stores, dealers, and Radio Shack Computer Centers for $9.95.

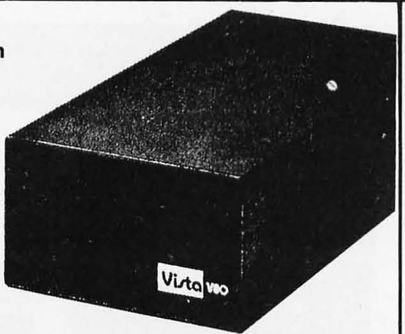
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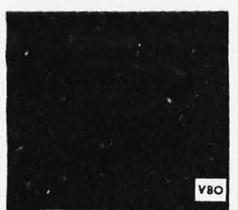
The Supermarket for TRS-80* Add-on Components (and other computers, too)

In stock now. Immediate delivery.

The Vista V-80/800/8000 Family Disk Drive System

- Fully compatible with TRS-80, Heath/Zenith
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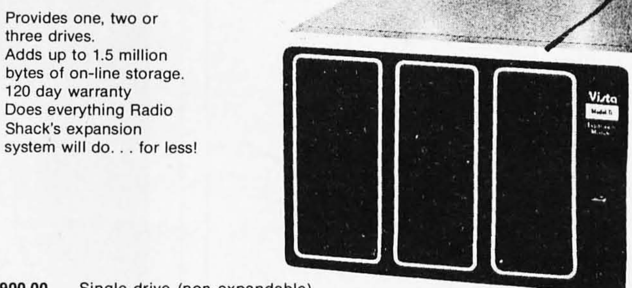




V-80 Single drive system (102K)	$ 395.00
V-80 Two drive system (204K)	$ 770.00
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V-800-2 Double drive, B52 Drives (408K)	$1175.00
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V-8000-2 Double drive B92 Drives (816K)	$1450.00

The VISTA Model II

- Provides one, two or three drives.
- Adds up to 1.5 million bytes of on-line storage.
- 120 day warranty
- Does everything Radio Shack's expansion system will do... for less!



$ 900.00	Single drive (non-expandable)
$1000.00	Single drive Expansion System
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$2100.00	Three drive Expansion System
$ 525.00	Additional drives alone

Vista's Add on Drives for Apple™

Speed . Capacity . Price

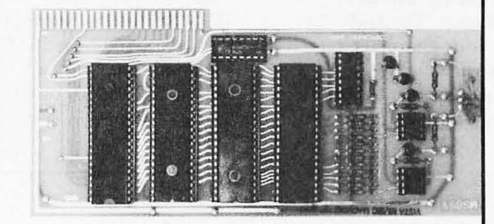
More for Less

- 30 to 60% cheaper per byte
- From 20 to 400% more capacity
- Twice as fast
- Compatible with Pascal
- Warranty 120 days

40-Track	$365.00
80-Track	$595.00
160-Track	$825.00
Controller	$100.00

The Vista MUSIC MACHINE 9





WITH 9 VOICES!

- NEW! Uses latest State of the Art LSI Technology.
- Requires only one slot for 9 voices!
- Uses three Ay3-8910's to produce nine voices (Other competitive models have only 3 voices).
- Simulates three ALF Boards.
- Plays music generated by the ALF Board.
- APPLE™ II compatible.
- ALF™ software required.

3 Times More Powerful Than ALF™!

$129.95

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Vista V300 Daisy wheel Letter quality	$1895.00
Base 2 Printer Variable line spacing control 0 to 64 dots in half dot increments 100 cps — six densities Standard 96 character ASCII Up to 10 character fonts	$575.00 (includes: 2-K Buffer, graphics, high speed tractor feed)
Anadex DP8000 9 x 7 dot matrix 80 column (112 cps)	$895.00
Vista Printer 5 x 7 dot matrix 80 column (125cps)	$745.00

Add On Drives

MPI B51	40 Track, Double Density-204K	$275.00
MPI B52	Dual Head, Double Density-408K	$375.00
Siemens	FDD100-5 40 Track Double Density 204K	$275.00
Siemens	FDD100-8 8" Single Sided Drive	$448.00
Shugart	801R Single Sided Drive	$448.00

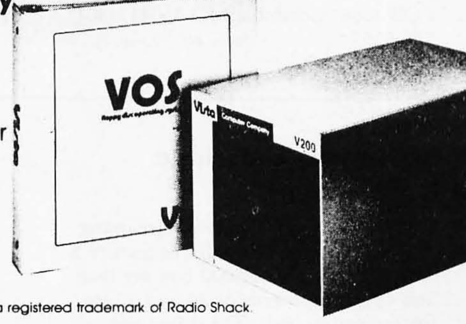
Other Products

1. VISTA Verbatim diskettes (hard or soft sector) Certified 40 track	$ 38.95
2. 16K RPM upgrade kits, guaranteed for 120 days. **PRIME PRODUCT**	$ 59.95
3. NEW! DOS +	$110.00
4. LNW expansion bare board	$ 66.95
5. H.C. Pennington book, **TRS-80 Disk and Other Mysteries**	$ 18.95
6. DDT Disco-Tech disk drive timer	$ 19.95

The VISTA V-200 for Exidy

- Completely packaged system, tested and ready to plug in, includes: power supply, two 40 track drives, case, controller, all cabling and total CPM documentation.
- Storage capacity from 400K to 1.2 meg.
- System software-VISTA CP/M Disk Operating System and BASIC-E Compiler recorded on 5-1/4" diskettes.

Price: Starting as low as **$1199.00**





CALL TOLL-FREE 800-854-8017

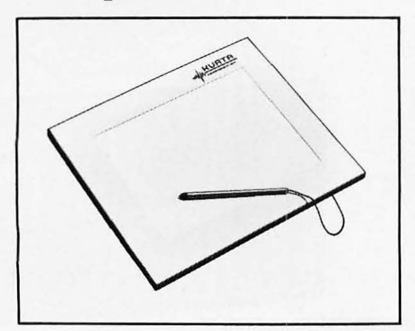
*TRS-80 is a registered trademark of Radio Shack.

The Vista Computer Company 1401 Borchard Street • Santa Ana, California 92705 • 714/953-0523

What's New?

PERIPHERALS

A Graphic Tablet

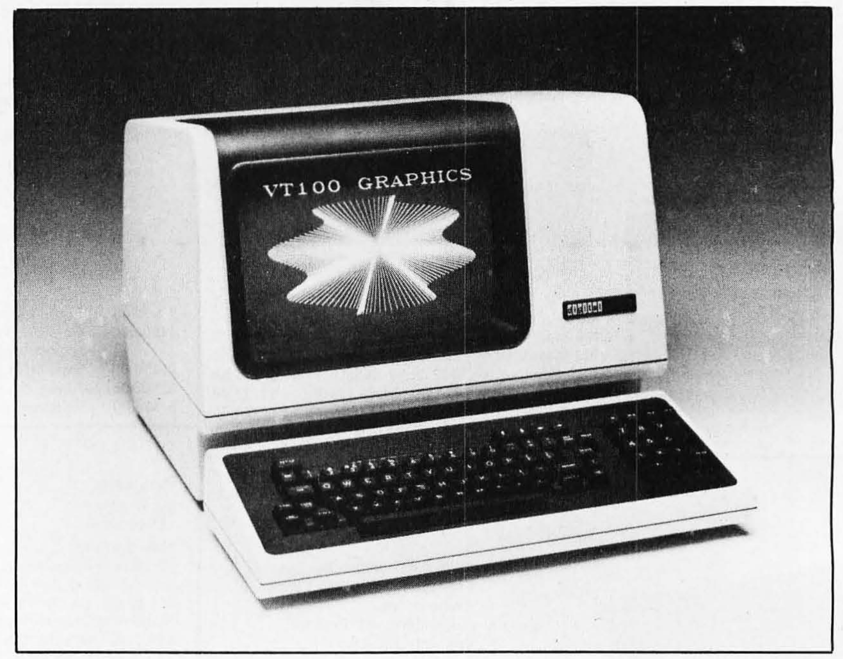


This graphic tablet, designed for small computers, is compatible with standard 7 by 9 inch display screens. For hard copy, a standard 8½- by 11-inch pad of paper fits onto the tablet surface. The output of the tablet matches the capabilities of the computer, thereby minimizing interface and software requirements. The resolution is 100 to 200 points per inch. Conversion rate is 100 coordinate pairs per second; standard output is bisequential with an optional full parallel output. The tablet is available from Kurta Corporation, 206 S River Dr, Tempe AZ 85281, (602) 968-8709. Circle 440 on inquiry card.

IEEE-488-to-Parallel Interface for the PET

The P.I.E.-C is an IEEE-488-to-parallel interface for the Commodore PET computer. The device has parallel output with two handshaking lines and is compatible with Centronics printers, NEC Spinwriter, Anderson-Jacobson AJ841, Integral Data System's Paper Tiger, Anadex 8000 and 9000 printers, and any other parallel-input ASCII (American Standard Code for Information Interchange) printer. The conversion of nonstandard PET codes to ASCII codes is switch-selectable. The P.I.E.-C with case, code converter, and printer cable is $119.95. Contact LemData Products, POB 1080, Columbia MD 21044, (301) 730-3257. Circle 441 on inquiry card.

Graphics Board for VT-100 and VT-103 Terminals



The Graphics-100 board fits in DEC (Digital Equipment Corporation) VT-100 and 103 video terminals to give them X,Y graphics display capability. The board provides a 1220 by 240 dot resolution on the screen. The text capability includes four character sets, three text rotations for labeling, and three type fonts. Graphics 100 memory and VT-100 memory may be displayed simultaneously. The unit includes a vector generator. Hard copy is available from the DECwriter II printer. Options include a light pen capability and software support under Selanar's PL II FORTRAN Plotting Subroutines. The Graphics-100 board is $1195; from Selanar, 2403 De La Cruz Blvd, Santa Clara CA 95050, (408) 727-2811.
Circle 442 on inquiry card.

Pascal-100 from Digicomp Research

Pascal-100 consists of two mated boards with a Z80 microprocessor subsystem and the Pascal Microengine integrated-circuit set. Pascal-100 upgrades S-100 systems to a bilingual bus and runs the complete UCSD Pascal in native code, plus all Z80, 8080, and CP/M software. Both microprocesor subsystems can address 128 K bytes of memory or, optionally, up to 1 megabyte of memory. The system requires 48 K bytes of storage. The system is a 16-bit, plug-in module for all S-100 systems. The price is $1485. UCSD Pascal for the unit is $250, and a 1-megabyte memory addressability option is $95. Contact Digicomp Research, Terrace Hill, Ithaca NY 14850, (607) 273-5900.

Circle 443 on inquiry card.

Streaming Cartridge Tape Drives

The Sidewinder family of streaming 1/4-inch cartridge tape drives feature a recording density of 8000 bits per inch and operating speeds of 30 and 90 ips (inches per second). The drives are designed for Winchester disk drive backup. They are offered in a Basic or Intelligent configuration with 10- or 20-megabyte capacities. Sidewinder's erase-write-read recording head operates in a two- or four-track format; the tracks are recorded serially. A microprocessor-based controller is supplied with the Intelligent Sidewinder. In OEM (original equipment manufacturer) quantities, the Basic Sidewinder is $469 for 10 megabytes and $600 for 20 megabytes. The Intelligent models are priced at $823 for 10 megabytes and $954 for 20 megabytes. Contact Archive Corporation, 3540 Cadillac Ave, Costa Mesa CA 92626, (714) 641-0279.

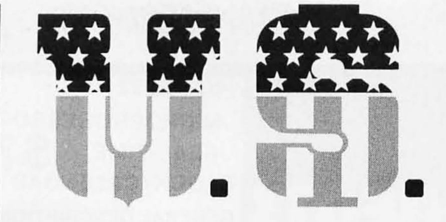
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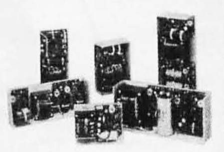
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(ILLINOIS RESIDENTS CALL: 815-485-4002) ★ 8:00 a.m. to 6:30 p.m.

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Please allow personal check to clear before shipment.

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+5V @ 9A	–5V @ .8A	+24V @ 7A	US-384	89.00
SHUGART – SIEMANS – MPI 5¼"				
+5V @ .5A	+12V @ .9A		US-340	33.50
+5V @ 2A	+12V @ 4A		US-323	56.25
SHUGART – SIEMANS – CDC 8"				
+5V @ 1A	–5V @ .5A	+24V @ 1.5A	US-205	52.50
+5V @ 2A	–5V @ .5A	+24V @ 3A	US-206	69.00
+5V @ 3A	–5V @ .6A	+24V @ 5A	US-162	89.00
+5V @ 1.7A	–5V @ 1.5A	+24V @ 2A	US-272	69.00
+5V @ 2A	+12V @ .4A	–12V @ .4A	US-HTAA	37.50

TELEVIDEO 912C

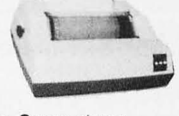
SOROC IQ120– $675.00
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Also have 920C, SOROC, HAZELTINE, etc. What we don't have is room on this page. Call Toll Free 800 number for prices.

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$499.00



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ATARI

800 – $899.00
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As long as there is a price war, we will fight your battle. Compare at your local Dept. store and buy U$ MICRO.

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BASF FLOPPIES

BOX OF 10 ONLY:

5¼"	SOFT	$2.65 ea.
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8"	SOFT 1D	3.25 ea.
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SPECIAL OF THE QUARTER

DUAL DRIVE SUBSYSTEM

$995.00

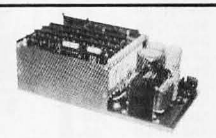


2 SHUGART 801R POWER SUPPLY

If this looks like a Lobo Drive System, don't be fooled. Just because it looks like one, works like one, smells like one, and tastes like one (?) doesn't mean it has to cost like one!

S1-MOD (KIT)

$239.00



Complete S-100 12 Slot Computer. Ample system power with regulated power for drives. Excellent for Subsystem or Hobby use. 4 hours to build. (6 conn. incl., less fans)

EXPANDABLE RAM

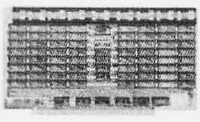
★SPECIAL★SPECIAL★SPECIAL★

This is the best all around 64K board you can buy. If after you see it, you don't agree return (unassembled) for full refund. Bank Select by extended address lines or I.O. 40H



★ $389.00 A&T★

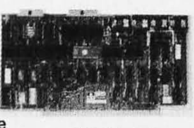
32K STATIC (KIT)



You have seen this well known board around for years. We bought 500 of them and plan on cornering the market! Bank Select on extended address lines.

$388.00

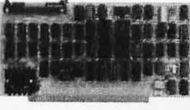
Z-80 CPU (KIT)



The first time this world popular CPU offered in Kit. 2 serial, 3 parallel, CTC, EProm Z-80 at 4 mhz. Software buad rate, etc. (less Prom)

$212.00

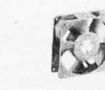
DMA DISK CONTROLLER (KIT)



How many DMA Disk Controllers are there on the market? Can't mention the name at this LOW, LOW, LOW, price.

$265.00

FANS $14.95



These are brand new, in the box fans. Not noisey bearing pullouts. Never again at these low prices!

3-1/8"   4-5/8"

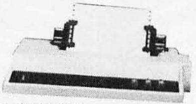
SPECIALS OF THE MONTH

4116s $4.25

Expansion 16K Dynamic RAMs for Apple, TRS-80 S-100 systems. T.I., Mostek Intel, Call for manufacturer.

200 NS

DIP-80 $399.00



Don't be mislead by this LOW price. This is a rugged 100% Duty Cycle 7 by 7 Dot Matrix Printer. Brand new, factory warr.

- RS-232 ADD $65.00
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One of the world's two most popular STATIC RAMs. Factory prime tested units. Sold in lots of 8 only. FUJITSU, HITACHI, etc.

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TMS-4044 / MM-5257 / INTEL 2147 $4.25

250 NS

The other of the world's most popular STATIC RAMs. This one is 4K by 1 organization. Don't buy Gold, buy these, the price won't last!

2716s $13.50 (450 NS)
2708s $6.95 (450 NS)

Remember when 2716s were $50.00 and hard to get? These units are so beautiful it's hard to part with them. But we will, for a small price. Guaranteed!

SHUGART DRIVE

8" 851R $585.00

8" 801R $385.00

Manufacturer had too many, buys at 1000 piece rate, sales dropped, so we got'em. Fantastic buy, get them while they last! Full warranty.

5¼" MINI $265.00

Now is the time to expand that Trash-80 or Rotton Apple (no offense!) These go so fast. Quantities limited to those on hand. Hurry ! No Junkers! Factory warranty.

SHUGART / SIEMANS / MPI

Circle 274 on inquiry card.

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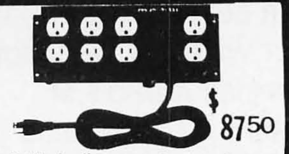
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MSM5832 MICROPROCESSOR REAL-TIME CLOCK/CALENDAR $7.45

GENERAL DESCRIPTION

The MSM5832 is a monolithic, metal-gate CMOS integrated circuit that functions as a real time clock/calendar for use in bus-oriented microprocessor applications. The on-chip 32,768 Hz crystal controlled oscillator time base is counted down to provide addressable 4-bit I/O data of SECONDS, MINUTES, HOURS, DAY-OF-WEEK, DATE, MONTH, and YEAR. Data access is controlled by 4-bit address, chip select, read, write and hold inputs. Other functions include 12H/24H format selection, leap year identification and manual ± 30 second correction



$87.50

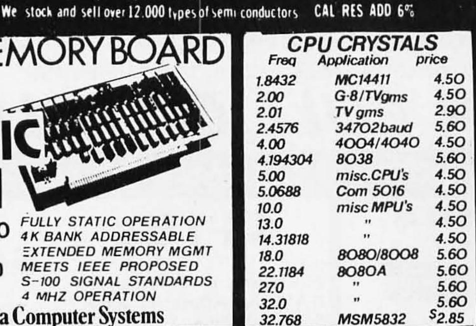
No "Glitches", Surges Or Interference

The MPD 117 is the low-cost solution to your power distribution problems. The MPD 117 has a high-performance EMI filter, built-in circuit breaker, two direct and six switched outlets, illuminated "on-off" switch for switched outlets, and is built with rugged UL-approved components and housing in an all-steel chassis with convenient mounting flanges.



TRS-80
16 K Memory Add-On
$46.66 KIT
With jumpers and instructions

S-100 MEMORY BOARD 16K STATIC RAM



$249.00
ASSEMBLED & TESTED

FULLY STATIC OPERATION
4K BANK ADDRESSABLE
EXTENDED MEMORY MGMT
MEETS IEEE PROPOSED S-100 SIGNAL STANDARDS
4 MHZ OPERATION

California Computer Systems

CPU CRYSTALS

Freq	Application	price
1.8432	MC14411	4.50
2.00	G-8/TVgms	4.50
2.01	TV gms	2.90
2.4576	34702baud	5.60
4.00	4004/4040	4.50
4.194304	8038	5.60
5.00	misc.CPU's	4.50
5.0688	Com 5016	4.50
10.0	misc MPU's	4.50
13.0	"	4.50
14.31818	"	4.50
18.0	8080/8008	5.60
22.1184	8080A	5.60
27.0	"	5.60
32.0	"	5.60
32.768	MSM5832	$2.85

video 100



$129 Leedex Corp.

12" BLACK & WHITE LOW COST VIDEO MONITOR

apple II plus

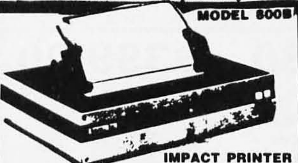
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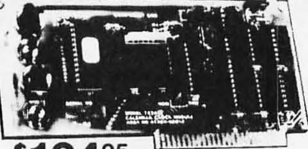
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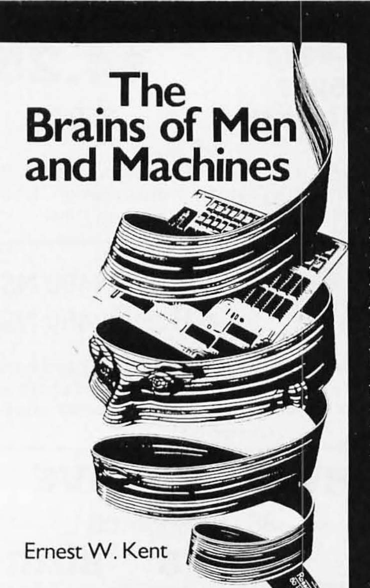
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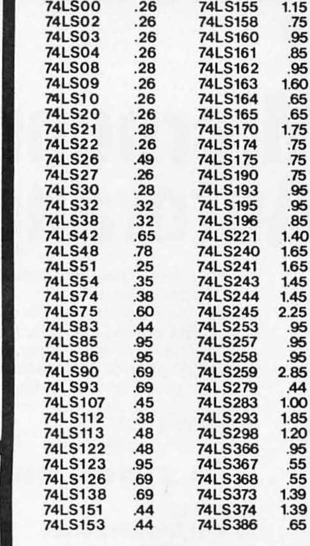
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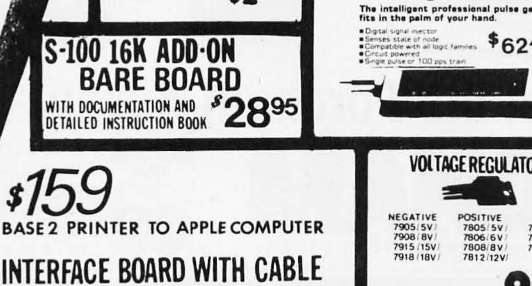
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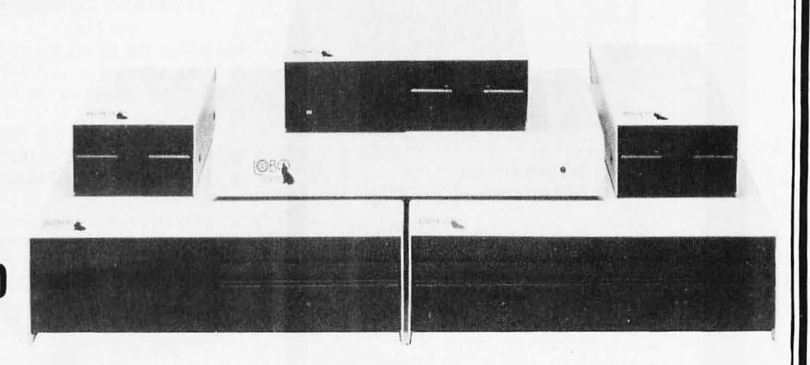


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7406	.33	7476	.45	74165	.85
7407	.35	7480	.45	74166	1.05
7408	.27	7483	.60	74167	1.35
7409	.24	7485	.75	74170	1.60
7410	.17	7486	.42	74173	1.30
7411	.22	7489	1.60	74174	.85
7412	.22	7490	.50	74175	.75
7413	.42	7491	.55	74176	.75
7414	.90	7492	.50	74177	.75
7416	.33	7493	.50	74180	.75
7417	.37	7494	.60	74181	1.90
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7430	.17	74122	.39	74194	.85
7432	.27	74123	.42	74195	.65
7437	.27	74125	.45	74196	.85
7438	.27	74126	.45	74197	.87
7440	.17	74145	.75	74279	.95
7441	.85	74150	1.10	74325	2.25
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74LS05	.35	74LS157	.85
74LS08	.35	74LS160	1.10
74LS09	.35	74LS161	1.10
74LS10	.30	74LS162	1.10
74LS11	.45	74LS163	1.20
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74LS86	.45	74LS259	1.50
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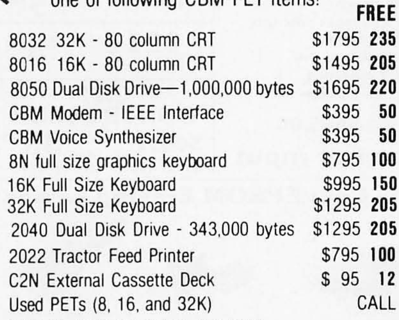


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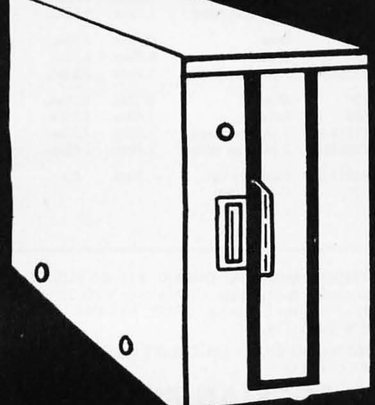
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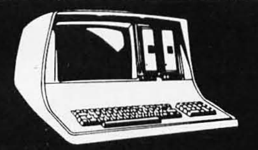
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15435	12/24 S/E PET	.140	2.60	2.35	2.10
15440	12/24 S/T PET	.140	2.65	2.40	2.15
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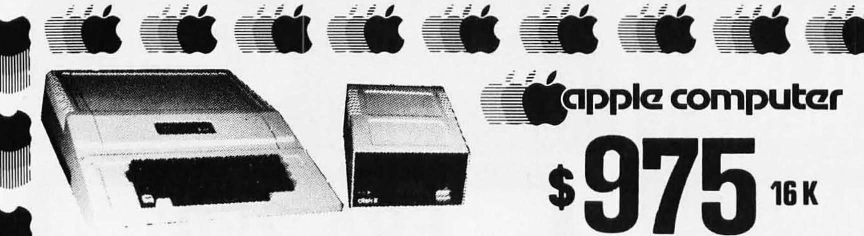
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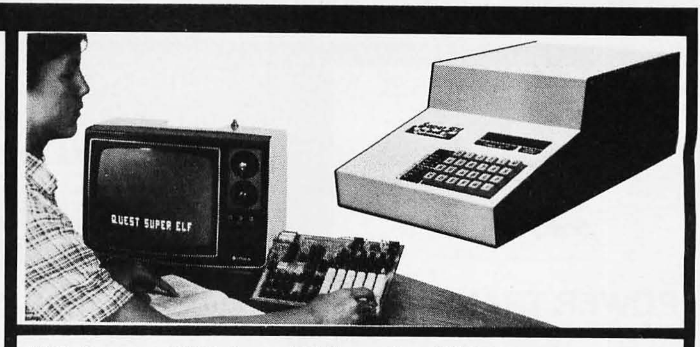
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Questdata, a software publication for 1802 computer users is available by subscription for $12.00 per 12 issues. Single issues $1.50. Issues 1-12 bound $16.50.

Tiny Basic Cassette **$10.00**, on ROM **$38.00**, original Elf kit board **$14.95. 1802 software;** Moews Video Graphics **$3.50.** Games and Music **$3.00**, Chip 8 Interpreter **$5.50.**

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A IK Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $15.25 for easy connection between the **Super Elf** and the **Super Expansion Board.**

Power Supply Kit for the complete system (see Multi-volt Power Supply).

Announcing Quest Super Basic— *SECOND GENERATION*

A new enhanced version of **Super Basic** now available. Quest was the first company worldwide to ship a full size Basic for 1802 Systems. A complete function **Super Basic** by **Ron Cenker** including floating point capability with scientific notation (number range $\pm .17E^{38}$), 32 bit integer ± 2 billion; multi dim arrays, string arrays; string manipulation; cassette I/O; save and load, basic, data and machine language programs; and over 75 statements, functions and operations.

Enhancements include increased speed, built-in provisions for Stringy Floppy, Floppy Disc, Printer Driver, I/O, user definable command library and statement renumbering.

Easily adaptable to most 1802 systems. Requires 16K RAM minimum for Basic and user programs. Source listing for both Serial and Parallel I/O included.

Super Basic on Cassette $40.00.

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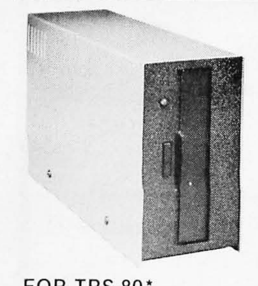
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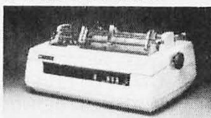
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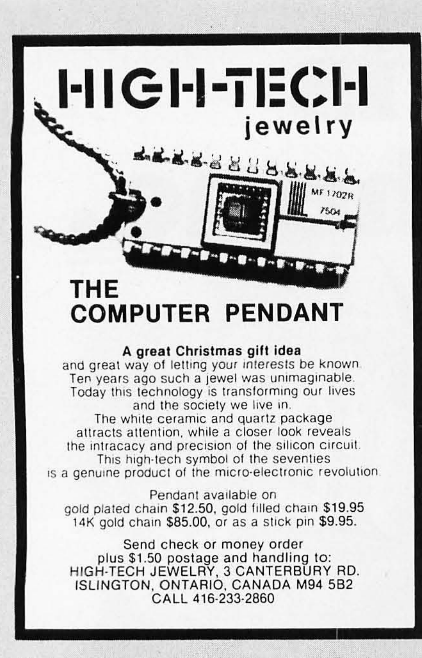
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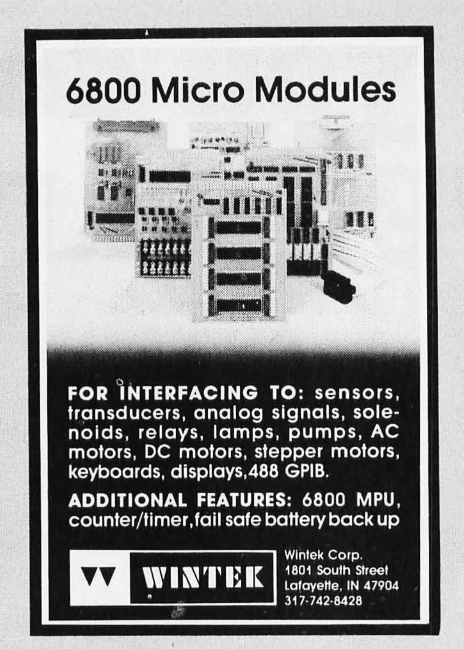
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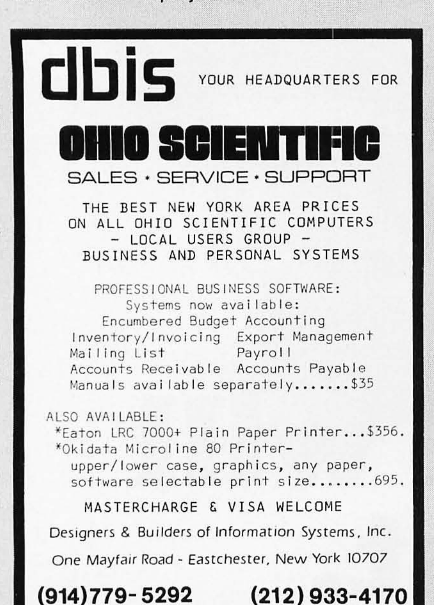
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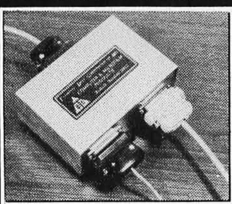
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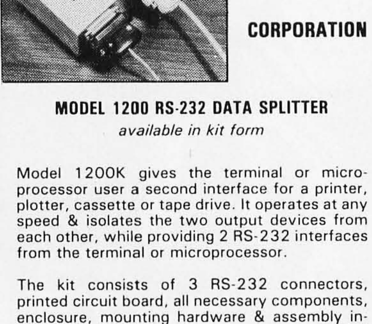


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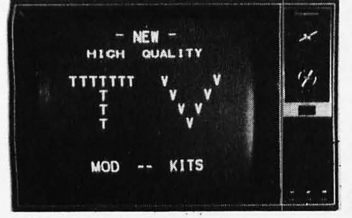
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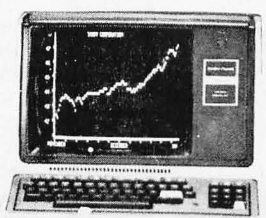
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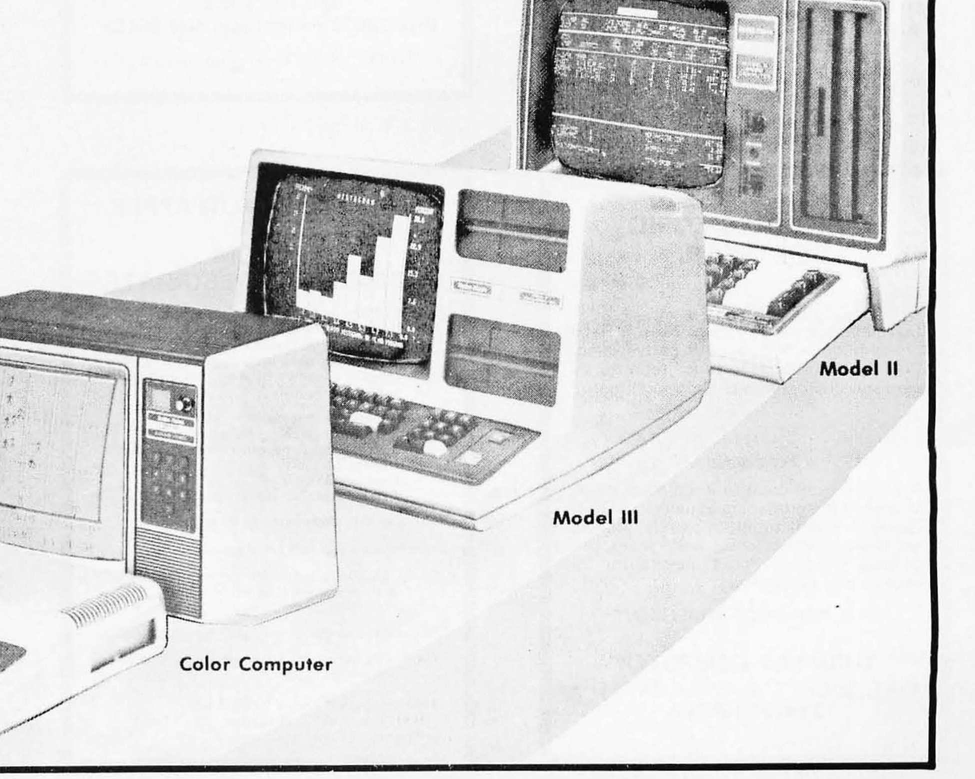
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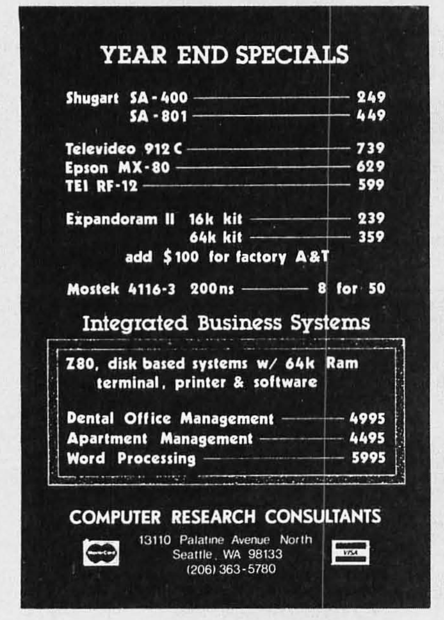
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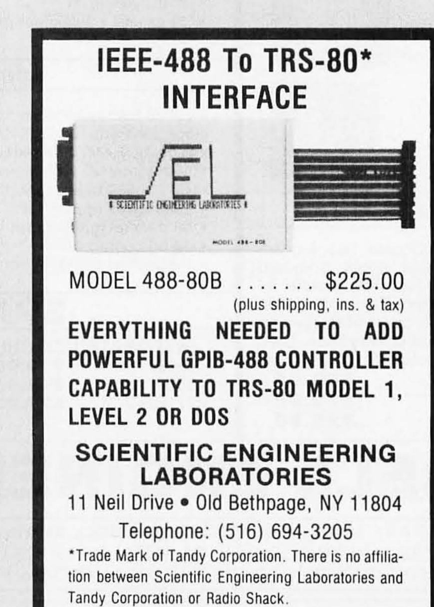
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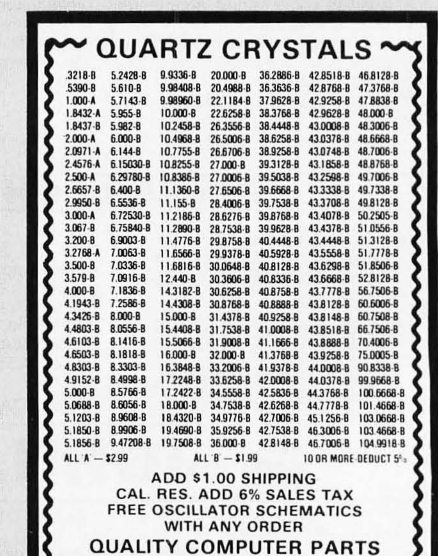
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.3218-B	5.2428-B	9.9336-B	20.000-B	36.2886-B	42.8518-B	46.8128-B
.5390-B	5.610-B	9.98408-B	20.4988-B	36.3636-B	42.8768-B	47.3768-B
1.000-A	5.7143-B	9.98960-B	22.1184-B	37.9628-B	42.9258-B	47.8838-B
1.8432-A	5.955-B	10.000-B	22.6258-B	38.3768-B	42.9628-B	48.000-B
1.8437-B	5.982-B	10.2458-B	26.3556-B	38.4448-B	43.0008-B	48.3006-B
2.000-A	6.000-B	10.4968-B	26.5006-B	38.6258-B	43.0378-B	48.6668-B
2.0971-A	6.144-B	10.7755-B	26.6706-B	38.9258-B	43.0748-B	48.7006-B
2.4576-A	6.15030-B	10.8255-B	27.000-B	39.3128-B	43.1858-B	48.8768-B
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2.6657-B	6.400-B	11.1360-B	27.6506-B	39.6668-B	43.3338-B	49.7338-B
2.9950-B	6.5536-B	11.155-B	28.4006-B	39.7538-B	43.3708-B	49.8128-B
3.000-A	6.72530-B	11.2186-B	28.6276-B	39.8768-B	43.4078-B	50.2505-B
3.067-B	6.75840-B	11.2890-B	28.7538-B	39.9628-B	43.4378-B	51.0556-B
3.200-B	6.9003-B	11.4776-B	29.8758-B	40.4448-B	43.4448-B	51.3128-B
3.2768-A	7.0063-B	11.6566-B	29.9378-B	40.5928-B	43.5558-B	51.7778-B
3.500-B	7.0336-B	11.6816-B	30.0648-B	40.8128-B	43.6298-B	51.8506-B
3.579-B	7.0916-B	12.440-B	30.3606-B	40.8336-B	43.6668-B	52.8128-B
4.000-B	7.1836-B	14.3182-B	30.6258-B	40.8758-B	43.7778-B	56.7506-B
4.1943-B	7.2586-B	14.4308-B	30.8768-B	40.8888-B	43.8128-B	60.6006-B
4.3426-B	8.000-B	15.000-B	31.4378-B	40.9258-B	43.8148-B	60.7508-B
4.4803-B	8.0556-B	15.4408-B	31.7538-B	41.0008-B	43.8518-B	66.7506-B
4.6103-B	8.1416-B	15.5066-B	31.9008-B	41.1666-B	43.8888-B	70.4006-B
4.6503-B	8.1818-B	16.000-B	32.000-B	41.3768-B	43.9258-B	75.0005-B
4.8303-B	8.3303-B	16.3848-B	33.2006-B	41.9378-B	44.0008-B	90.8338-B
4.9152-B	8.4998-B	17.2248-B	33.6258-B	42.0008-B	44.0378-B	99.9668-B
5.000-B	8.5766-B	17.2422-B	34.5558-B	42.5836-B	44.3768-B	100.6668-B
5.0688-B	8.6056-B	18.000-B	34.7538-B	42.6268-B	44.7778-B	101.4668-B
5.1203-B	8.9608-B	18.4320-B	34.9776-B	42.7006-B	45.1256-B	103.0668-B
5.1850-B	8.9906-B	19.4690-B	35.9256-B	42.7538-B	46.3006-B	103.4668-B
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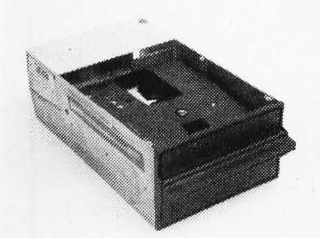
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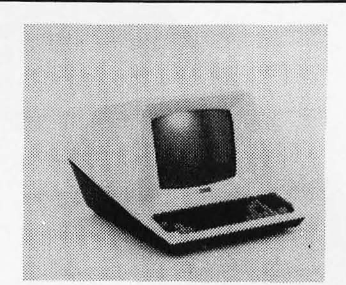


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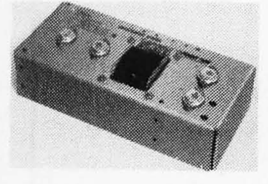
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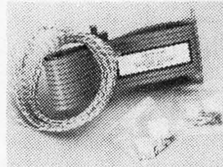
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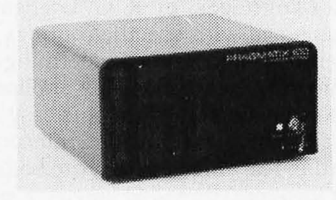
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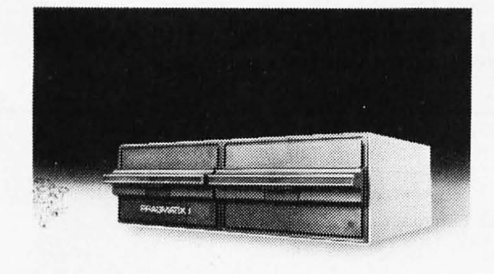
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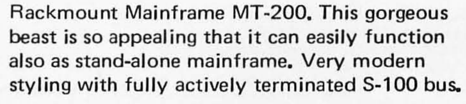


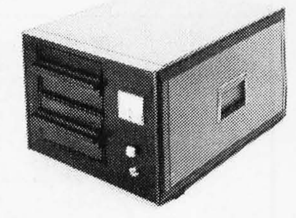
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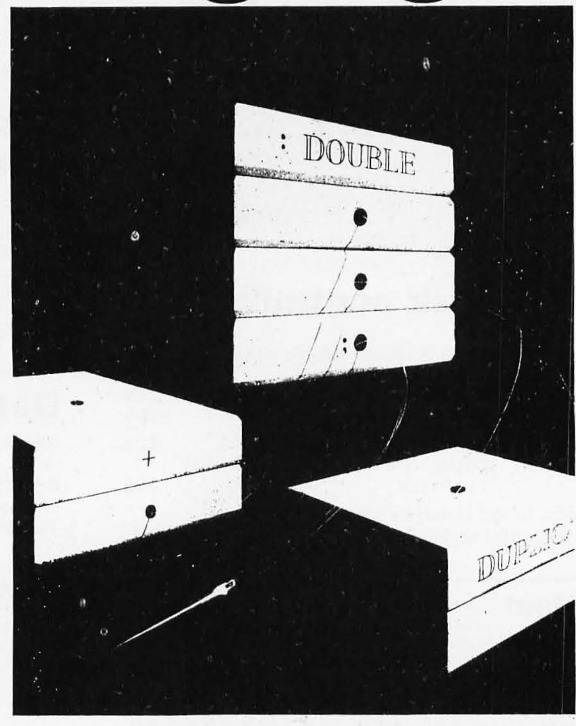
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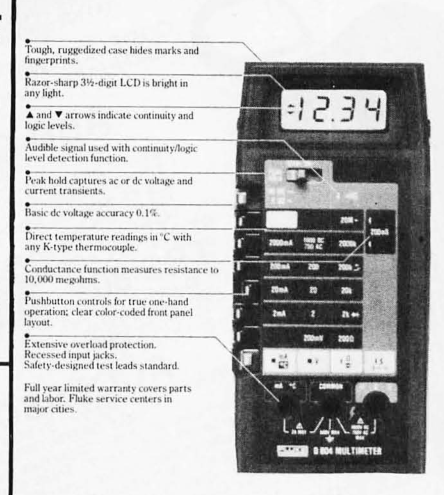
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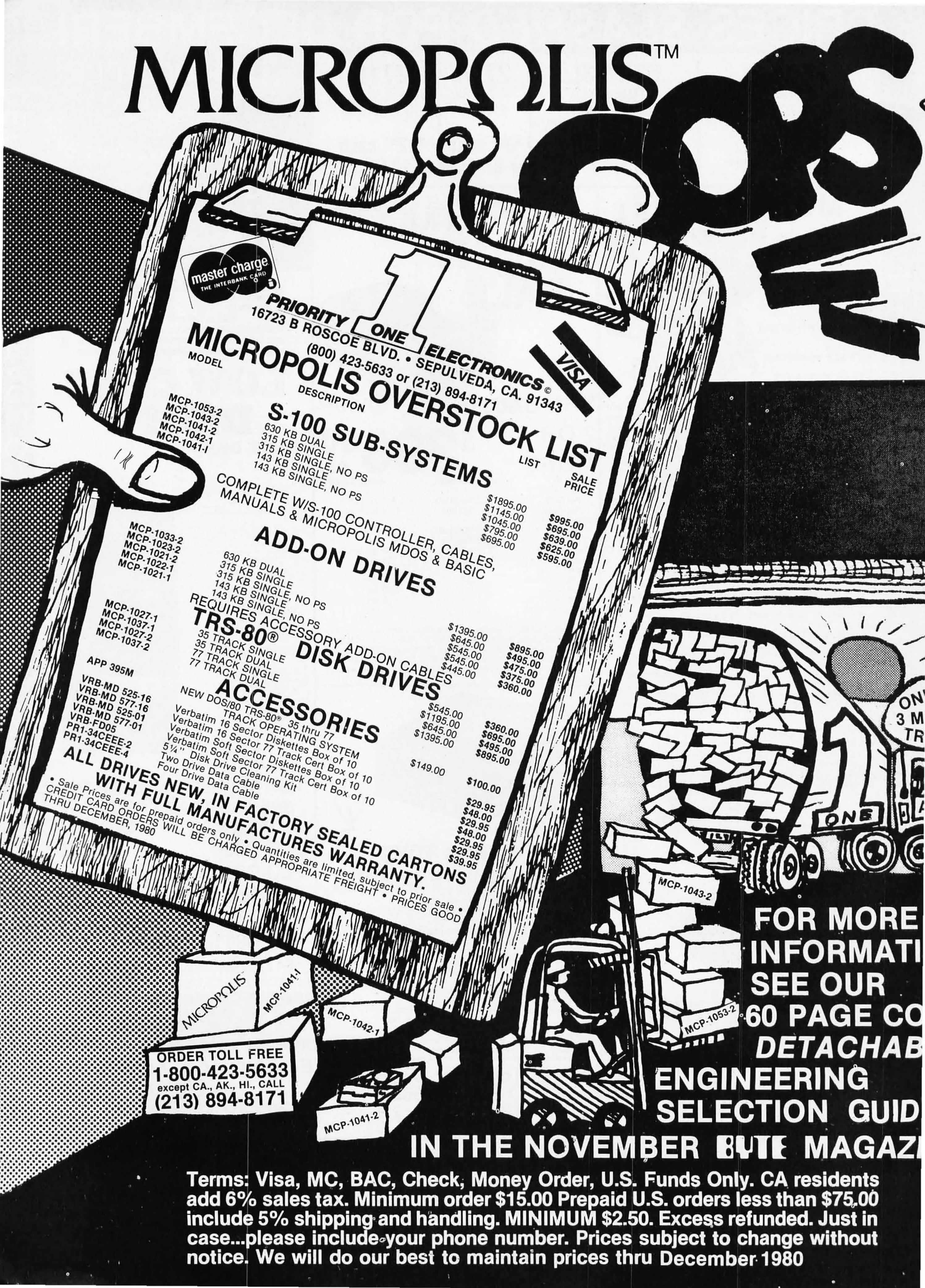
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Terms: Visa, MC, BAC, Check, Money Order, U.S. Funds Only. CA residents add 6% sales tax, Minimum order $15.00 Prepaid U.S. orders less than $75.00 include 5% shipping and handling. MINIMUM $2.50. Excess refunded. Just in case ... please include your phone no. Prices subject to change without notice. We will do our best to maintain prices thru December, 1980.
*SOCKET and CONNECTOR prices based on GOLD, not exceeding $500 per oz.

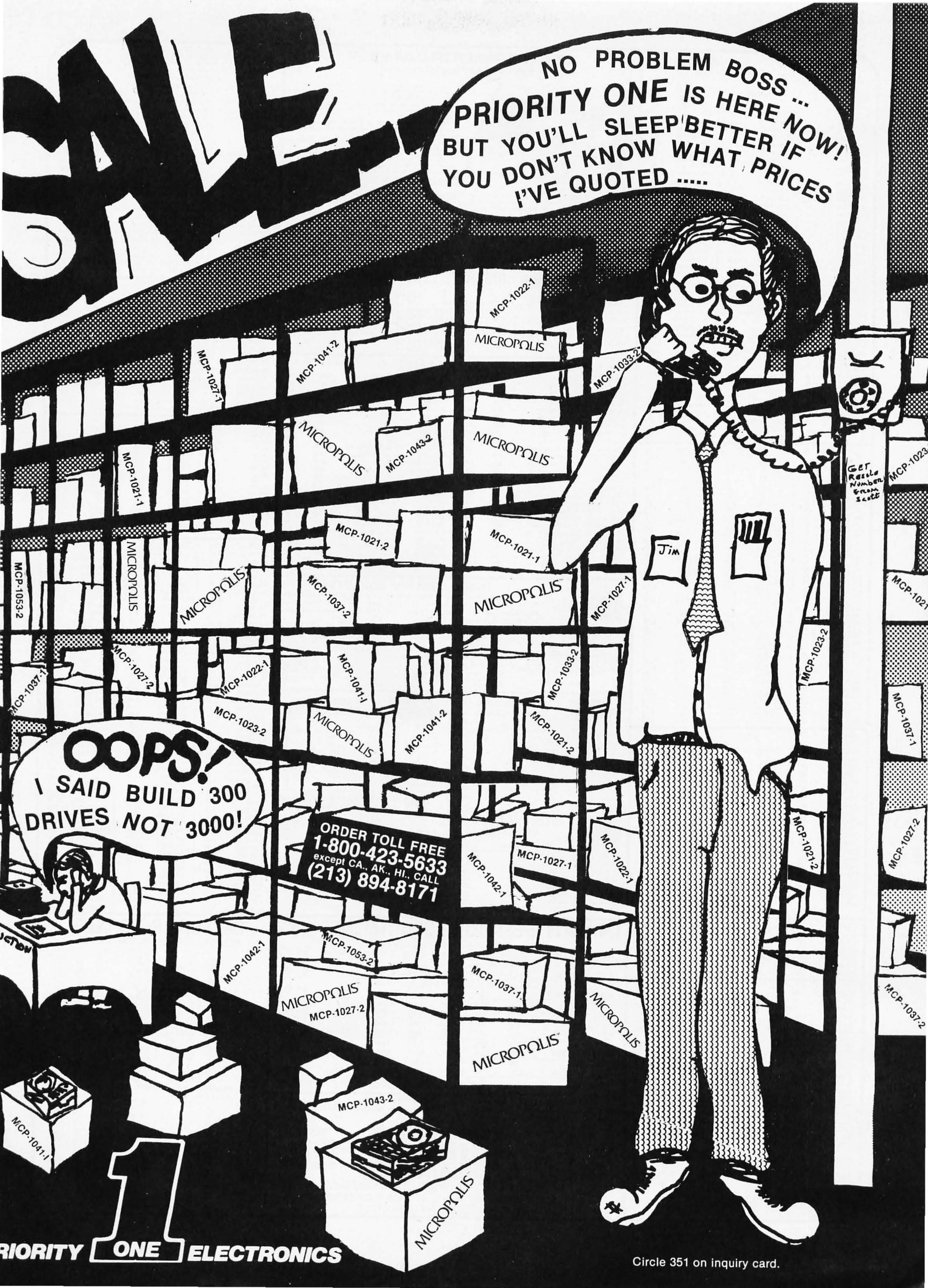
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Circle 351 on inquiry card.

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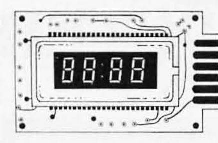
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(800) 423-5633 or (213) 894-8171
MICROPOLIS OVERSTOCK LIST
MODEL DESCRIPTION LIST SALE PRICE
S-100 SUB-SYSTEMS
MCP-1053-2 630 KB DUAL $1895.00 $995.00
MCP-1043-2 315 KB SINGLE $1145.00 $695.00
MCP-1041-2 315 KB SINGLE, NO PS $1045.00 $639.00
MCP-1042-1 143 KB SINGLE $795.00 $625.00
MCP-1041-I 143 KB SINGLE, NO PS $695.00 $595.00
COMPLETE W/S-100 CONTROLLER, CABLES, MANUALS & MICROPOLIS MDOS & BASIC
ADD-ON DRIVES
MCP-1033-2 630 KB DUAL $1395.00 $895.00
MCP-1023-2 315 KB SINGLE $645.00 $495.00
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MCP-1021-1 143 KB SINGLE, NO PS $445.00 $360.00
REQUIRES ACCESSORY ADD-ON CABLES
TRS-80® DISK DRIVES
MCP-1027-1 35 TRACK SINGLE $545.00 $360.00
MCP-1037-1 35 TRACK DUAL $1195.00 $695.00
MCP-1027-2 77 TRACK SINGLE $645.00 $495.00
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APP 395M NEW DOS/80 TRS-80® 35 thru 77 TRACK OPERATING SYSTEM $149.00 $100.00
VRB-MD 525-16 Verbatim 16 Sector Diskettes Box of 10 $29.95
VRB-MD 577-16 Verbatim 16 Sector 77 Track Cert Box of 10 $48.00
VRB-MD 525-01 Verbatim Soft Sector Diskettes Box of 10 $29.95
VRB-MD 577-01 Verbatim Soft Sector 77 Track Cert Box of 10 $48.00
VRB-FD05 5¼" Disk Drive Cleaning Kit $29.95
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ALL DRIVES NEW, IN FACTORY SEALED CARTONS WITH FULL MANUFACTURES WARRANTY.
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Circle 352 on inquiry card.

National Semiconductor Clock Modules



12VDC AUTOMOTIVE/ INSTRUMENT CLOCK

APPLICATIONS:
- In-dash autoclocks
- After-market auto/ RV clocks
- Aircraft-marine clks.
- 12VDC oper. instru.
- Portable/battery powered instrumnts.

Features: Bright 0.3" green display. Internal crystal timebase. ± 0.5 sec./day accur. Auto. display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete—just add switches and lens.

MA1003 Module $16.95

MA1023 .7" Low Cost Digital LED Clock Module	8.95
MA1026 .7" Dig. LED Alarm Clock/Thermometer	18.95
MA5036 .3" Low Cost Digital LED Clock/Timer	6.95
MA1002 .5" LED Display Dig. Clock & Xformer	9.95



National Semiconductor

RAM SALE

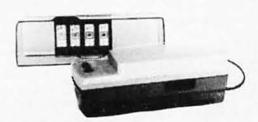
MM5290J-2 (MK4116/UPD416)... **$6.95 each**
16K DYNAMIC RAM (150NS)
(8 EACH $49.95) (100 EACH $550.00/lot)

MM5298J-3A .... $3.25 each
8K DYNAMIC RAM (LOW HALF OF MM5290J) 200NS
(8 EACH $23.95) (100 EACH $250.00/lot)

MM2114-3 .... $5.95 each
4K STATIC RAM (300NS)
(8 EACH $43.95) (100 EACH $450.00/lot)

MM2114L-3 .... $6.25 each
4K STATIC RAM (LOW POWER 300NS)
(8 EACH $44.95) (100 EACH $475.00/lot)

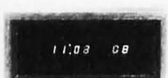
EPROM Erasing Lamp



- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch.
- Special conductive foam liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact — only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips.

UVS-11E $79.50

Jumbo 6-Digit Clock Kit



- Four .630"ht. and two .300"ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE747 .... $29.95

6-Digit Clock Kit

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701 .... $19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3½" x 5" x 2"H

JE200 .... $14.95



ADAPTER BOARD —Adapts to JE200— ±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

JE205 .... $12.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A	CPU	6.50
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	7.95
DP8253	Prog. Interval Timer	14.95
DP8255	Prog. Peripheral I/O (PPI)	9.95
DP8257	Prog. DMA Control	19.95
DP8259	Prog. Interrupt Control	14.95
DP8275	Prog. CRT Controller	49.95
DP8279	Prog. Keyboard/Display Interface	19.95
DP8300	Octal Bus Receiver	6.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	14.95
MC6802CP	MPU with Clock and RAM	19.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	10.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	13.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	15.95
CDP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MCS6502	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	16.95
INS8039N-6	CPU—Sgl. Chip 8-Bit (128 bytes RAM)	19.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
P8085	CPU	19.95
INS8900	CPU—16-Bit	29.95
TMS9900JL	MPU—16-Bit	49.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402	256-Bit Dynamic	3.95
MM5013	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	.89
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V (1404A)	1024-Bit Dynamic	3.95
2518N	Hex 32-Bit Static	4.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 250-Bit Static	4.00
2529V	Dual 240-Bit Static	4.00
2532N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Pass Filter	19.95
AF122-1CJ	Touch Tone Low Pass Filter	19.95
LM308AH	Super Gain Op Amp	1.00
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.5ppm/C°)	4.95
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0809CCN	8-Bit A/D Converter (8-Ch. Multi.)	5.25
ADC0817CCN	8-Bit A/D Converter (16-Ch. Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	30K BAUD UART	5.95

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
21L02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	5.95
2114L	1024x4 Static 450ns Low Power	6.95
2114-3	1024x4 Static 300ns	7.49
2114L-3	1024x4 Static 300ns Low Power	7.95
2117	16,384x1 Dynamic 550ns (house marked)	4.95
MM2147J	4096x1 Fast 70ns	19.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.25
MM5280/2107	4096x1 Dynamic	4.95
MM5290J-2(4116)	16K Dynamic 250ns (UPD416)	6.95
MM5298J-3A	8K Dyn. 200ns (lower ½ of MM5290J)	4.95
7489	16x4 Static	1.75
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	14.95
TMS4045	1024x4 Static	14.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	9.95
TMS2716	16K EPROM (-5V, +5V, +12V)	19.95
2716Intel(2516)TI	16K EPROM (Single +5V)	17.95
2732Intel(2532)TI	32K EPROM	49.95
2758	8K EPROM (450ns) (Single +5V)	7.95
5203	2048 PROM	14.95
82S23(74S188)	32x8 PROM (Open Collector)	4.95
82S115	4096 Bipolar PROM	19.95
82S123(74S288)	32x8 Tri-State Bipolar PROM	4.95
82S185	8K PROM	29.95

ROM'S

2513(2140)	Character Generator (Upper Case)	9.95
2513(3021)	Character Generator (Lower Case)	9.95
2516N	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

NMOS READ ONLY MEMORIES

MCM66710P	128x9x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

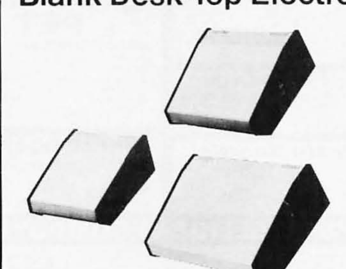
SPECIAL FUNCTION

DS0025CN	Dual MOS Clock Driver (5MZ)	3.50
DS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
MM58167N	Microprocessor Real Time Clock	8.95
MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Int.	7.49
COP470N	32-Seg. VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

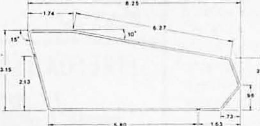
AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM53190N	Push Button Pulse Dialer	7.95
MM57499N	96/144-Key Serial Keyboard Encoder	8.95

DESIGNERS' SERIES
Blank Desk-Top Electronic Enclosures



- High strength epoxy molded end pieces in mocha brown finish.
- Sliding rear/bottom panel for service and component accessibility.
- Top/bottom panels .080 thk alum. Alodine type 1200 finish (gold tint color) for best paint adhesion after modification.
- Vented top and bottom panels for cooling efficiency.
- Rigid construction provides unlimited applications.

CONSTRUCTION:
The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an internal slot (all around) to accept both top and bottom panels. The panels are then fastened to ¼" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/ bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.



Enclosure Model No.	Panel Width	PRICE
DTE-8	8.00"	$29.95
DTE-11	10.65"	$32.95
DTE-14	14.00"	$34.95

$10.00 Min. Order — U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage—Add 5% plus $1 Insurance

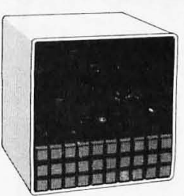
Spec Sheets — 25¢
1981 Catalog Available — Send 41¢ stamp



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12/80 PRICES SUBJECT TO CHANGE

COMPUTER CUBE T.M.



COMPUTER CRT MONITOR & ACCESSORY CASE
- One piece heavy duty molded construction
- Painted to match Apple II & III (Lt. beige, textured finish)
- Smoke colored acrylic front cover (removable)
- Built-in shelf holds CRT and allows room for 2 Apple disk drives below shelf
- Three 2½" holes provided in bottom of case for addition of fan if needed.
- Fan hole positioned above Apple motherboard location.
- Hookup cables can be run through other 2 holes.
- Case accommodates most B&W and Color uncased CRT monitors made by Motorola, Ball Bros., Zenith, Sanyo, Panasonic, Hitachi, etc. or any monitor that will fit into 10-3/8"H x 14½"W x 13¾"D space.
- Size: 15" x 15" x 15" O.D., 14½"H x 14½"W x 13¾"I.D.
- Weight: approximately 12 lbs.
- CRT monitor fan and disk drives not included.

CUBE-1 .... $99.95

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
- ★ 8 each MM5290-2 (UPD416) (16K Dynamic Rams) (250NS or less)
- ★ Documentation for conversion

TRS-16K $49.95

JE610 ASCII Encoded Keyboard Kit



The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10 mA for operation. Features: 60 keys generate the 126 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector.

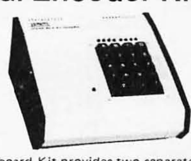
JE610 (Case not included) **$79.95**
K62 (Keyboard only) $34.95

Desk-Top Enclosure for JE610 ASCII Encoded Keyboard Kit

Compact desk-top enclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3½"H x 14½"W x 8¾"D.

DTE-AK $49.95
SPECIAL: JE610/DTE-AK PURCHASED TOGETHER (Value $129.90) $124.95

JE600 Hexadecimal Encoder Kit



FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation.

JE600 (Case not included) **$59.95**
K19 (Keyboard only) $14.95

Desk-Top Enclosure for JE600 Hexadecimal Keyboard Kit

Compact desk-top exclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3½"H x 8¾"W x 8¾"D.

DTE-HK $44.95
SPECIAL: JE600/DTE-HK PURCHASED TOGETHER (Value $104.90) $99.95

Circle 352 on inquiry card.

7400

Part	Price	Part	Price
SN7400N	.19	SN74123N	.59
SN7401N	.22	SN74125N	.39
SN7402N	.22	SN74126N	.44
SN7403N	.22	SN74128N	.59
SN7404N	.22	SN74132N	.69
SN7405N	.23	SN74136N	.95
SN7406N	.23	SN74139N	.95
SN7407N	.23	SN74141N	.69
SN7408N	.26	SN74142N	2.95
SN7409N	.23	SN74143N	2.95
SN7410N	.22	SN74144N	2.95
SN7411N	.29	SN74145N	.62
SN7412N	.29	SN74147N	1.95
SN7413N	.39	SN74148N	1.20
SN7414N	.59	SN74150N	.99
SN7416N	.29	SN74151N	.67
SN7417N	.29	SN74152N	.67
SN7420N	.22	SN74153N	.67
SN7421N	.35	SN74154N	1.19
SN7422N	.29	SN74155N	.82
SN7423N	.29	SN74156N	.89
SN7425N	.29	SN74157N	.69
SN7426N	.29	SN74158N	1.65
SN7427N	.29	SN74160N	.95
SN7429N	.45	SN74161N	.95
SN7430N	.23	SN74162N	.89
SN7432N	.29	SN74163N	.87
SN7437N	.29	SN74164N	.97
SN7438N	.29	SN74165N	.97
SN7439N	.29	SN74166N	1.20
SN7440N	.24	SN74167N	1.95
SN7441N	.79	SN74170N	1.69
SN7442N	.57	SN74172N	5.95
SN7443N	.79	SN74173N	.79
SN7444N	.79	SN74174N	.89
SN7445N	.79	SN74175N	.89
SN7446N	.79	SN74176N	.85
SN7447N	.59	SN74177N	.85
SN7448N	.79	SN74179N	1.80
SN7450N	.23	SN74180N	.75
SN7451N	.23	SN74181N	1.75
SN7453N	.23	SN74182N	.75
SN7454N	.23	SN74184N	1.95
SN7459N	.29	SN74185N	1.95
SN7460N	.23	SN74186N	9.95
SN7470N	.39	SN74188N	3.90
SN7472N	.34	SN74190N	1.15
SN7473N	.38	SN74191N	1.15
SN7474N	.36	SN74192N	.85
SN7475N	.38	SN74193N	.85
SN7476N	.36	SN74194N	.85
SN7479N	4.60	SN74195N	.85
SN7480N	.59	SN74196N	.85
SN7481N	1.10	SN74197N	.85
SN7482N	1.10	SN74198N	1.39
SN7483N	.55	SN74199N	1.39
SN7485N	.65	SN74221N	1.39
SN7486N	.39	SN74251N	.95
SN7489N	1.75	SN74273N	1.05
SN7490N	.39	SN74279N	.89
SN7491N	.65	SN74283N	2.15
SN7492N	.52	SN74284N	3.90
SN7493N	.49	SN74285N	3.90
SN7494N	.72	SN74290N	1.25
SN7495N	.65	SN74298N	.95
SN7496N	.72	SN74365N	.68
SN7497N	3.10	SN74366N	.68
SN74100N	.99	SN74367N	.79
SN74107N	.32	SN74368N	.79
SN74109N	.53	SN74390N	1.90
SN74116N	1.95	SN74393N	1.90
SN74121N	.29	SN74490N	1.90
SN74122N	.39		

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CD4001	.35	CD4094	2.95
CD4002	.35	CD4098	2.49
CD4006	1.39	CD4099	2.25
CD4007	.29	MC14408	12.95
CD4008	1.39	MC14409	12.95
CD4009	.49	MC14410	12.95
CD4010	.49	MC14412	12.95
CD4011	.35	MC14415	8.95
CD4012	.29	MC14419	4.95
CD4013	.49	CD4501	.39
CD4014	1.39	CD4502	1.65
CD4015	1.15	CD4503	.69
CD4016	.59	CD4505	8.95
CD4017	1.19	CD4506	.75
CD4018	.99	CD4507	.95
CD4019	.49	CD4508	3.95
CD4020	1.19	CD4510	1.39
CD4021	1.19	CD4511	1.39
CD4022	1.15	CD4512	1.39
CD4023	.38	CD4515	3.95
CD4024	.79	CD4516	1.69
CD4025	.38	CD4518	1.39
CD4027	.65	CD4520	1.39
CD4028	.85	CD4555	4.95
CD4029	1.29	CD4556	.99
CD4030	.45	CD4566	2.25
CD4031	3.25	74C00	.39
CD4032	2.15	74C02	.39
CD4034	3.25	74C04	.39
CD4035	.95	74C08	.49
CD4037	1.95	74C10	.49
CD4040	1.29	74C14	1.65
CD4041	1.25	74C20	.39
CD4042	.95	74C30	.39
CD4043	.85	74C32	.99
CD4044	.85	74C42	1.85
CD4046	1.75	74C48	2.39
CD4047	1.25	74C73	.85
CD4048	.99	74C74	.85
CD4049	.69	74C85	2.49
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CD4051	1.10	74C90	1.85
CD4052	1.10	74C93	1.85
CD4053	1.10	74C95	1.85
CD4055	3.95	74C107	1.19
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CD4059	9.95	74C154	3.50
CD4060	1.39	74C157	2.10
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CD4069	.35	74C161	2.30
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CD4072	.35	74C173	2.59
CD4073	.35	74C174	2.75
CD4075	.35	74C175	2.75
CD4076	1.29	74C192	2.39
CD4077	.35	74C193	2.39
CD4078	.35	74C195	2.39
CD4081	.35	74C922	7.95
CD4082	.35	74C923	6.95
CD4085	1.95	MM80C95	1.50
CD4089	2.95	MM80C97	1.25

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Part	Price	Part	Price
74LS00N	.35	74LS164N	1.19
74LS01N	.28	74LS165N	.89
74LS02N	.28	74LS166N	2.48
74LS03N	.28	74LS168N	1.89
74LS04N	.39	74LS169N	1.89
74LS05N	.28	74LS170N	1.99
74LS08N	.39	74LS173N	.89
74LS09N	.39	74LS174N	.99
74LS10N	.28	74LS175N	.99
74LS11N	.39	74LS181N	2.20
74LS12N	.39	74LS190N	1.15
74LS13N	.47	74LS191N	1.15
74LS14N	1.25	74LS192N	.98
74LS15N	.39	74LS193N	.98
74LS20N	.26	74LS194N	1.15
74LS21N	.38	74LS195N	.95
74LS22N	.38	74LS196N	.89
74LS26N	.39	74LS197N	.89
74LS27N	.39	74LS221N	1.49
74LS28N	.39	74LS240N	1.95
74LS30N	.26	74LS241N	1.90
74LS32N	.39	74LS242N	1.95
74LS37N	.79	74LS243N	1.95
74LS38N	.39	74LS244N	1.95
74LS40N	.26	74LS245N	4.95
74LS42N	.79	74LS247N	1.10
74LS47N	.79	74LS248N	1.10
74LS48N	.79	74LS249N	1.69
74LS51N	.26	74LS251N	1.79
74LS54N	.35	74LS253N	.98
74LS55N	.35	74LS257N	.98
74LS73N	.45	74LS258N	.98
74LS74N	.59	74LS259N	2.95
74LS75N	.68	74LS260N	.69
74LS76N	.45	74LS261N	2.49
74LS78N	.65	74LS266N	.59
74LS83AN	.99	74LS273N	1.75
74LS85N	1.19	74LS275N	4.40
74LS86N	.45	74LS279N	.59
74LS90N	.75	74LS283N	1.10
74LS92N	.75	74LS290N	1.29
74LS93N	.75	74LS293N	1.95
74LS95N	.88	74LS295N	1.10
74LS96N	.98	74LS298N	1.29
74LS107N	.45	74LS324N	1.75
74LS109N	.45	74LS347N	1.95
74LS112N	.49	74LS348N	1.95
74LS113N	.49	74LS352N	1.65
74LS114N	.55	74LS353N	1.65
74LS122N	.55	74LS363N	1.49
74LS123N	1.19	74LS365N	.99
74LS124N	1.35	74LS366N	.99
74LS125N	.89	74LS367N	.73
74LS126N	.89	74LS368N	.73
74LS132N	.79	74LS373N	2.75
74LS136N	.59	74LS374N	2.75
74LS138N	.89	74LS375N	.69
74LS139N	.89	74LS377N	1.95
74LS145N	1.25	74LS385N	1.95
74LS148N	1.49	74LS386N	.65
74LS151N	.79	74LS390N	1.95
74LS153N	.79	74LS393N	1.95
74LS154N	2.49	74LS395N	1.70
74LS155N	1.19	74LS399N	2.95
74LS156N	.99	74LS424N	2.95
74LS157N	.99	74LS668N	1.75
74LS158N	.75	74LS670N	2.29
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LM108AH	2.95	LM1496N	.89
LM300H	.79	LM1556N	1.50
LM301CN/H	.35	LM1800N	.79
LM304H	.98	LM1820N	.95
LM305H	.89	LM1850N	.95
LM306H	3.25	LM1889N	3.95
LM307CN/H	.29	LM2111N	1.75
LM308CN/H	.98	LM2900N	.99
LM309K	1.49	LM2901N	2.50
LM310CN	1.25	LM2917N	2.95
LM311D/CN/H	.98	CA3013T	2.29
LM312H	1.75	CA3018T	1.99
LM317T	2.75	CA3021T	3.49
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LM319N/H	1.25	CA3035T	2.75
LM320K-XX*	1.49	CA3039T	1.49
LM320T-XX*	1.25	CA3046T	1.29
LM320H-XX*	1.25	LM3053N	1.49
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LM324N	1.25	CA3060N	3.25
LM339N	.95	CA3062N	4.95
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LM340T-XX*	1.25	CA3080N	1.29
LM340H-XX*	1.25	CA3081N	1.69
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LM348N	1.85	CA3083N	1.99
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LM360N	1.49	CA3089N	2.75
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LM739N	1.15	SN75453N	.49
LM741CN/H	.33	SN75454N	.49
LM741CN-14	.19	SN75491N	.89
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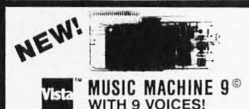
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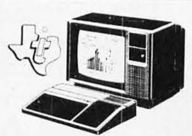


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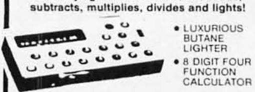
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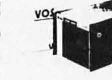
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SAVE $300.00 ($1799.00 VALUE)

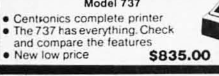


WATANABE MIPLOT

Max pen speed 50 mm/sec., resolution .10 mm typically .05 mm, built-in character generator sizes and 4 degrees of rotation, absolute draw, relative draw, alpha printing done with simple commands. **$1195.00**

IMS STATIC RAM BOARDS

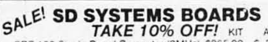
	250 ns.	450 ns.
8K Static	$209.00	$189.00
16K Static	$449.00	$399.00
32K Static	$729.00	$629.00



CENTRONICS PRINTER

Model 737

- Centronics complete printer
- The 737 has everything. Check and compare the features
- New low price **$835.00**



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Z80 Starter System	319.00	449.00
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SD100 Computer System w/64K	-	6995.00
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6800 MICROMODULE™ PRICE LIST

MODEL NO.	DESCRIPTION	PRICE
9600A	Single Board Microcomputer	$495.00
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9601	16 Slot Mother Board	175.00
9602	Card Cage	75.00
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9617	EPROM Programming Head	250.00
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9627	16K Static RAM Module 470ns	395.00
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9640	Multiple Programmable Timer	395.00
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96103	32/32 I/O Module	275.00
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$49.95 TRS-80/APPLE $49.95

MEMORY EXPANSION KITS, 4116's, 16K (200/250 ns.)
8 pcs for **$49.95**
w/instructions & jumpers
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EXPANDORAM II MEMORY KITS

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★ Write Protect ★ Power 8VDC, ±16VDC
★ Phantom ★ Up to 4 MHz

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16K	$269.00	48K	$435.00
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3.2 Mbytes capacity (unformatted), max. seek time 100MS.
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Holds 4 Eprom's at a time. Backed by 45 years experience.
Model S-52T... $265.00
Professional Industrial Model



EMAKO-20.. Reg. $777.00 $599.00

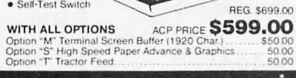
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Prints a 132 col/line. Available with parallel or serial output at same price



VISTA PRINTER

25 CPS, Full Character Daisy Wheel, 136 Column Model No. FP1500 **$1995.00**



BASE II PRINTER

80 Column Impact Printer

- 60 Lines Per Minute
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- 72, 80, 96, 120 or 132 Char/Line
- Self-Test Switch

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Z-80/Z-80A/8080 CPU BOARD

★ **On board 2708** ★ **2708 included (450ns.)**
★ **Power on jump** ★ **Completely socketed.**

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- 8" Drive with Double-Density
- 90 Day Warranty

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NOVATION CAT™ 0-300 Baud
Bell 103 Answer, Originate
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9512 Arith Processor 175.00
9513 Univ. Timing 79.95
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Z80A-CTC	4.0 MHz	12.95
Z80-DMA	2.5 MHz	29.95
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Z80-SIO/0	2.5 MHz	35.95
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Z80-SIO/1	2.5 MHz	35.95
Z80A-SIO/1	4.0 MHz	39.40
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2732 .... 74.95
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4702 .... 14.95
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2111	3.75	3.65	3.55
2112-1	2.95	2.85	2.65
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2114L-250ns. (4045)	6.50	5.95	5.50
2114L-450ns. (4045)	5.50	5.25	**4.75**
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EMM4200A	9.75	8.75	7.95
EMM4402	7.95	7.25	6.25
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AMD9130/31	12.95	11.95	10.25
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6518 1K x 1 CMOS	7.95	7.95	7.25
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Set of 8 416's 49.95
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4096 4K x 1 (16 Pin) 3.95
2104 4K x 1 (16 Pin) 4.75
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5262	1.95	4008L	4.95
5270	4.95	6605	7.95
5280	4.95	6604	4.95
5290	12.45	6002	1.50

64K RAMS $159.95

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# Pins	Lo-Pro Soldertail	Wire Wrap 3 Level Tin	Wire Wrap 3 Level Gold
8	.15	.32	.45
14	.19	.36	.59
16	.20	.38	.62
18	.24	.59	.84
20	.29	.69	.99
22	.24	.79	1.10
24	.38	.85	1.20
28	.43	1.10	1.49
36	.58	1.25	1.69
40	.60	1.40	1.89

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16 Pin $5.50 24 Pin $7.50 40 Pin $10.25

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Part No.	Size	Color	Description	Price
DL704	300	Red	Comm. Cathode	.99
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FND501	500	Red	Comm. Cathode (+1)	.99
FND503 (500)	500	Red	Comm. Cathode	.99
FND507 (510)	500	Red	Comm. Anode	.99
FND508	500	Red	Comm. Anode (+1)	.99
FND530	500	Green	Comm. Cathode	1.49
FND550	500	Orange	Comm. Cathode	1.49
FND803 (800)	800	Red	Comm. Cathode	1.75
FND807 (810)	800	Red	Comm. Anode	1.75
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HP5082-7300	600	Red	4 x 7 Sgl. Digit RHD	18.95
HP5082-7731	300	Red	Comm. Anode	.75
TIL305	-	Red	Array 5 x 7	7.95
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TIL309	270	Red	Numerical Display	9.95
TIL311	270	Red	4 x 7 Hexidecimal	10.95
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XAN3061	300	Red	Comm. Anode Right DP	1.25
XAN3062	300	Red	Comm. Anode Left DP	1.25
XAN3063	300	Red	Overflow, CA, Left DP	1.25
XAN3064	300	Red	Comm. Cathode Right DP	1.25
XAN3051	300	Green	Comm. Anode Right DP	1.99
XAN3052	300	Green	Comm. Anode Left DP	1.99
XAN3053	300	Green	Overflow CA, Left DP	1.99
XAN3054	300	Green	Comm. Cathode, Right DP	1.99
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XAN3082	300	Yellow	Comm. Anode, Left DP	2.10
XAN3083	300	Yellow	Overflow CA, Left DP	2.10
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LM 2917N Freq. to Volt Conv. 2/1.99
AY-3-3550 4¾ digit DMM 24.95
AY-5-3507 40MHz DVM 9.95
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ULN 2003A 7 channel Driver .... .99
2101AL-4 .... 1.95
MCM 14505 64 bit Static Ram 6.95
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SPX33 Opto Coupler 3/1.00

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100% CERTIFIED ERROR-FREE!

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525-16	16 Hole Hard, Micropolis	27.25

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577-10	10 Hole Hard NS, Apple, etc	32.25
577-16	16 Hole Hard, Micropolis	32.25

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3347 .... 5.95

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Anadex DP 8000	995.	875.
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Teletype Model 43	1349.	1150.
HiPlot Plotter	1085.	899.
HiPlot Digitizer	795.	735.
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Atari 400	549.	449.
TI 99/4	1150.	1025.
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CPU-30200B *Bare board* $35.00

SBC-100 - SD Systems
2.5 MHz Z-80 CPU with serial & parallel I/O ports*
CPC-30100K *Kit* $269.95
CPC-30100A *Jade A & T* $339.95

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CPC-30200A *Jade A & T* $375.00

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December 31 of January 1, 1981

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Dual 8" drive cutouts with 8 slot motherboard
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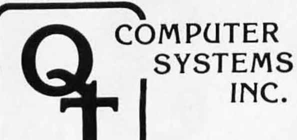
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QTC-MF+MD w/o M/B $400.00
Mainframe - T.E.I.
TEI-MCS-112 (12 slot M/B) $575.00
TEI-MCS-122 (22 slot M/B) $695.00

DISK DRIVES

QT DISK PACKAGE
Dbl Den Controller, A&T, two 8" dbl den drives, CP/M 2.2, cabinet, power supply & cables $1395.00
DUAL 8" DRIVES
Dbl Den Drives in Cabinet Only
2 sgl sided (801R) .... $ 989.00
2 dbl sided (QUME) $1409.00
8" DISK DRIVES
Highly reliable floppy disk drives sgl sided, dbl den
SHU-801R .... $ 425.00
Special Sale Price .... 2 for $800.00
Qume Datatrak 8" dbl sided, dbl density
QME-8DS (851R compatible) .... $ 599.00
Pkg of two .... $ 549.00 ea.
5¼" DRIVES
MPI-B51 MPI B-51 .... $ 275.00
Sgl Sided, Sgl/Dbl Den
Exact Replacement for SA-400
MPI-B52 MPI B-52 .... $ 395.00
Dbl Sided, Dbl Den
MPI-B91 MPI B-91 .... $ 395.00
Sgl Sided, Dbl Den, 77 Tracks
PER-FD200 PERTEC FD-200 .... $ 250.00
Sgl Sided, Sgl/Dbl Den

QT MOTHERBOARDS

QT Silence Plus
6 Slot (5¼" x 8⅝")
QTC-6 Slot BB Bare board $19.95
QTC-6 Slot K kit $39.95
QTC-6 Slot AT A&T $49.95
12 Slot (9¾" x 8⅝")
QTC-12 Slot BB Bare board $29.95
QTC-12 Slot K kit $69.95
QTC-12 Slot AT A&T $89.95
18 Slot (14½" x 8⅝")
QTC-18 Slot BB Bare board .... $ 49.95
QTC-18 Slot K kit .... $ 99.95
QTC-18 Slot AT A&T $139.95

QT APPLE CORNER

MEX-16A2 Apple Expansion Kit $37.00
Buy 4 Sets for $35.00
DISK DRIVE for APPLE
5¼" disk drive with controller for your Apple
APL-5DC with controller $535.00
APL-5D w/out controller $450.00
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Controller, two 8" drives, cabinet & cable $1450.00
QT APPLE DISK II
Dbl sided, dbl den, two 8" QUME drives with controller, pwr supply, cabinet, cabling, documentation & one box diskettes $2195.00
QT APPLE DISK III
Same as Above - no controller $1695.00
AI/O - S.S.M.
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SSM-AIO AT A&T $199.00
APPLE CLOCK - QT System
Real time clock w/battery back-up
QTC-CCA-AT A&T $125.00
SUPERTALKER - Mtn Hardware
Speech recognition/synthesizer w/speaker & mike
MHW-STLK A&T $275.00
Z-80 CARD for APPLE
Z-80 CPU card with CP/M for your Apple
MST-Z80 A&T $289.00
MICROMODEM - D.C. Hayes
Auto answer dial modem card for Apple or S-100
DCH-MM2 Apple modem $349.95
DCH-MM100 S-100 modem $375.00

TEXTOOL

ZIP* DIP II SOCKETS

16 PIN ZIP* DIP II .... $ 5.50
24 PIN ZIP* DIP II .... $ 7.50
40 PIN ZIP* DIP II $10.25
*ZERO INSERTION PRESSURE

BARE BOARDS AVAILABLE ON MANY PRODUCTS

S-100 PRODUCTS

WE ACCEPT M/C VISA & AM EXP

Double Density - Cal Comp Sys
5¼" or 8" disk controller with free CP/M 2.2
CCS-2422A A&T $374.95

SBC-100-SD Systems
2.5 MHz Z80 CPU with serial & parallel I/O ports
SDS-SBC100K Kit $269.95
SDS-SBC100AT A&T $339.95

SBC-200 - SD Systems
4 MHz Z80 CPU with serial & parallel I/O ports
SDS-SBC200K Kit $299.95
SDS-SBC200AT A&T $375.00

CB2 - S.S.M.
2 or 4 MHz switchable Z80 CPU with RAM, ROM & I/O
SSM-CB2K Kit $239.95
SSM-CB2AT A&T $299.95

2810 Z-80 CPU - Cal Comp Sys
2 or 4 MHz Z80A CPU w/serial I/O port
CCS-2810 A&T $275.00

ExpandoRAM I - SD Systems
2.5 MHz RAM board expandable from 16K to 64K
SDS-RAM16K 16K kit $245.00
SDS-RAM16AT 16K A&T $295.00
SDS-RAM32K 32K kit $275.00
SDS-RAM32AT 32K A&T $325.00
SDS-RAM48K 48K kit $305.00
SDS-RAM48AT 48K A&T $355.00
SDS-RAM64K 64K kit $335.00
SDS-RAM64AT 64K A&T $385.00

ExpandoRAM II - SD Systems
4 MHz RAM board expandable from 16K to 256K
SDS-RAM216K 16K kit $249.95
SDS-RAM216AT 16K A&T $299.95

SDS-RAM232K 32K kit $289.95
SDS-RAM232AT 32K A&T $339.95
SDS-RAM248K 48K kit $324.95
SDS-RAM248AT 48K A&T $374.95
SDS-RAM264K 64K kit $359.95
SDS-RAM264AT 64K A&T $409.95

16K Static RAM - Cal Comp Sys
2 or 4 MHz 16K static RAM - a real memory bargain
CCS-2016B 16K 2 MHz A&T $279.00
CCS-2016BCK 16K 4 MHz A&T $309.00

PB-1 - S.S.M.
2708, 2716 EPROM board with built-in programmer
SSM-PB1K kit $159.95
SSM-PB1AT A&T $239.95

PROM-100 - SD Systems
2708, 2716, 2732, 2758 & 2516 EPROM programmer
SDS-PROM-100K kit $175.00
SDS-PROM-100AT A&T $225.00

I/O-4 - S.S.M.
2 serial I/O ports plus 2 parallel I/O ports
SSM-IO4K kit $179.95
SSM-IO4AT A&T $259.95
SSM-IO4BB Bare board .... $ 35.00

SB1-S.S.M.
15 Hz to 25K Hz music synthesizer for S-100
SSM-SB1K kit $239.95
SSM-SB1AT A&T $299.95

S-100 Extender - Cal Comp Sys
Puts problem boards within easy reach
CCS-2520A A&T .... $ 24.95

Versafloppy I - SD Systems
Versatile floppy disk controller for 8" or 5¼"
SDS-VFIK kit $219.95
SDS-VFIAT A&T $269.95

Versafloppy II - SD Systems
New double density controller for both 8" & 5¼"
SDS-VF2K kit $309.95
SDS-VF2AT A&T $369.95

VDB-8024 - SD Systems
80 x 24 I/O mapped video board with keyboard I/O
SDS-VDBK kit $339.95
SDS-VDBAT A&T $399.95

VB3 - S.S.M.
80 x 24 x 48 memory mapped with graphics
SSM-VB3-4mhzK kit, 4 MHz $399.95
SSM-VB3-4mhzAT A&T, 4 MHz $464.95
SSM-VB3-4mhzUPG 80 x 48 upgrade, 4 MHz .... $ 89.00

VIDEO BOARD -Ithaca Audio
64 x 16 assembled & tested S-100 video board
IIS-VBDAT A&T $99.95

T1 Active Terminator
SSM-T1K kit .... $ 34.00
SSM-T1AT A & T .... $ 64.00

VB2 I/O Mapped Video Interface
SSM-VB2K kit $160.00
SSM-VB2AT A & T $210.00

XB1 Extender Board
SSM-XB1K kit (with Connector) .... $ 22.00
SSM-XB1AT A & T .... $ 30.00

Z-80 STARTER KIT - SD Systems
Z-80 computer with RAM, ROM, I/O & keyboard
SDS-Z80K kit $319.95
SDS-Z80AT A&T $399.95

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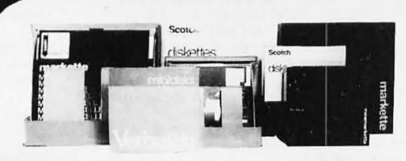
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CP/M and MP/M are trademarks of Digital Research.
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DISKETTES

FREE PLASTIC LIBRARY CASE INCLUDED WITH THE PURCHASE OF EVERY BOX OF DISKETTES

Private labeled for California Digital by one of the most respected producers of magnetic media. Each diskette is certified double density at 40 tracks. To insure extended media life each diskette is manufactured with a reinforced hub-hole. And of course, a plastic library case is included with every box of diskettes. MMD-CD5(01)(10) Please specify computer or required sectors.

$24.95 BOX

Ten boxes $22.75 One hundred boxes $21.50

MINIDISKETTES	Box	10 boxes		Box	10 boxes
Memorex 3401	$27.00	$25.00	Scotch 744(0)(10)(16)	$31.00	$29.00
Verbatim 525(01)(10)	29.00	27.00	Dysan	45.00	43.00

EIGHT INCH	Scotch	box	10 bx.	Dysan	box	10 bx.	MRX	box	10 bx.
Single side/single den.	740-0	$35.	$33.	3740/1	$49.	$47.	3060	$45.	$43.
Single side/double den.	741-0	45.	43.	3740/1d	75.	73.	3090	37.	35.
Single side/32 sector	740-32	35.	33.	na.			na.		
Double side/ double D.	743-0	65.	59.	na.			3115	49.	45.

SCOTCH brand head cleaning kit. $24.95 MMA-CK(5)(8) please specify 5 1/4 8"
Prices available on request for: tape, cartridges, diskpacks, volumn diskettes.

MEMORY

TRS-80 APPLE II $39

16k memory (8) 4116's

Installation is simple. Anyone who has ever changed a spark plug should be able to up-grade his microcomputer.
How can California Digital offer these memory up-grade sets at 25% below our competition? Simple, we buy in volume, wholesale to dealers and sell the balance directly to owners of personal microsystems. These 16K dynamic memory circuits are factory prime and unconditionally guaranteed for one full year. NOW, before you change your mind, pick up the telephone and order your up-grade memory from California Digital. Add $3 for TRS80 jumpers.

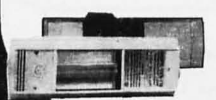
STATIC	1-31	32-99	100-5C	-999	1K+
21L02 450nS.	1.19	.99	.95	.90	.85
21L02 250nS.	1.49	1.39	1.25	*	*
2114 1Kx4 450	5.95	5.50	5.25	4.75	4.50
2114 1Kx4 300	8.95	8.50	8.00	*	*
4044 4Kx1 450	5.95	5.50	5.25	*	*
4044 4Kx1 250	9.95	9.50	9.00	*	*
4045 1Kx4 450	8.95	8.50	8.00	*	*
4045 1Kx4 250	9.95	9.50	9.00	*	*
5257 low pow.	5.95	5.50	5.00	4.80	4.60

2716 EPROM SALE $13

We have slashed price in an effort to reduce our over stocked inventory. These are single five volt EPROMs manufactured by one of the Worlds largest producers of semiconductors. All are first quality prime devices. Ceramic 450 nS.

FREE

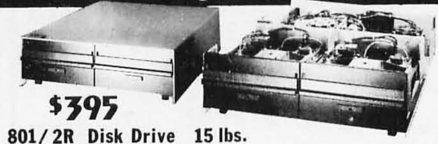
Ultra-Violet Products UVS 11-E UV EPROM ERASER



With purchase of FORTY 2716 EPROM's

$79 value

Shugart Associates



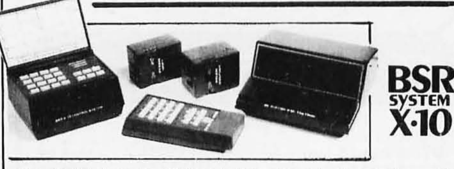
$395

801/2R Disk Drive 15 lbs.

Shugart 801/R with CP 206 power supply, muffin exhaust fan, complete in dual enclosure with all the necessary harnessing cables. Documentation included. 36 pounds. MSD-1801 **$795**

Same as above but with two Shugart 801R disk drives. 50 pounds. MSD-2801 **$1195**

Disk drive cable. 6 feet 50 conductor with edge card connector at both ends. WCA-650S $25.00
Export Disk drives. 220V. 50MHz add $50.00 per disk drive.



BSR SYSTEM X·10

The new BSR timer runs your home just like clockwork. Turns on lamps and appliances while your away from home. Completely compatible with your existing System X-10 devices.

BSR Timer eight channel	$65.00	Appliance Module 500 W.	$13.95
Master control console	34.95	Lamp Module 300 Watts	13.95
Ultrasonic Controller	19.95	NEW full control wall switch	14.50



BMC VIDEO MONITOR $259

Green phosphor with 18 MHz bandwidth, composit video input make the BMC KG-12C an ideal monitor for anyone requiring a high resolution 12" display.
High impact plastic enclosure assures that the BMC monitor is a rugged take anywhere instrument. For added protection the unit is equipped with a removable smoked non-glare plexiglas screen. VDM-BMC 18 lbs.



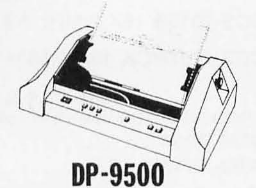
PRINTRONIX $4500

Forty-four separate print heads shuttle to provide overlapping dots. This unique feature allows a resolution of 60 dots per inch horizontal and 72 vertical.
The Printronix P-300 has the capability of outputing pictures, bar codes and large labels, a feature not provided with band or chain printers. PRP-300 200 lbs.

P-300

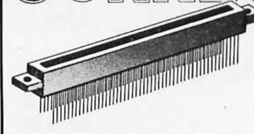
Anadex

$1395
PRX 9500



DP-9500

CONNECTORS



MALE

FEMALE

GOLD EDGE CONNECTORS

S-100 .125" centers	each	10+
Imsai solder .250" row	$2.95	$2.50
Imsai wire wrap (TI)	3.95	3.50
Sullins Hi-Rel. .250"	4.50	4.00
Sullins Hi-Rel. W/W	5.35	4.90
Sullins/Altair .140"	4.95	4.50
.156" Centers (standard)		
22/44 Kim Eyelet	2.50	2.15
36/72 Digital Group S/T	5.95	5.50
36/72 Digital Group W/W	6.60	6.15
43/86 Motorola 6800 S/T	6.60	6.15
43/86 Moto. 6800 W/W	7.00	6.85

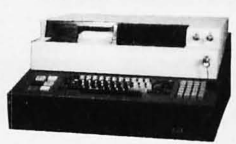
INTEGRATED CIRCUIT SOCKETS

	Low Profile each	Low Profile 100+	Wire Wrap each	Wire Wrap 100+
8 pin	$.10	$.09	$.46	$.41
14 pin	.10	.09	.45	.41
16 pin	.12	.11	.50	.45
18 pin	.15	.13	.68	.61
24 pin	.26	.24	.94	.87
40 pin	.42	.40	1.60	1.47

"D" Type	each	10-24	25+
DE9P male	$1.60	$1.40	$1.30
DE9S female	2.25	2.00	1.90
DE hood	1.50	1.35	1.20
DA15P male	2.35	2.15	2.00
DA15S female	3.25	3.10	2.90
DA hood 2/P	1.60	1.35	1.30
DB25P male	2.50	2.35	2.25
DB25S female	3.35	3.15	3.05
DB hood 2/P	1.35	1.15	1.05
DC37P male	4.20	4.00	3.70
DC37S female	6.00	5.75	5.50
DC hood 2/P	2.25	2.00	1.75
DD50P male	5.50	5.10	4.75
DD50S female	9.40	8.60	8.00
DD50 hood 2/P	2.60	2.40	2.10
CENTRONICS			
57-30360	7.95	6.75	5.75
RIBBON CABLE CONNECTORS			
17/34 5" disk	4.85	4.15	3.95
20/40 TRS-80	5.65	5.05	4.70
25/50 8" disk	5.90	5.15	4.90

SURPLUS

IBM 2980 SELECTRIC BANK TERMINAL



$250

The IBM 2980 terminal was designed to be located at each tellers station in a branch bank. Information entered into the terminal would instantaneously adjust the customers account at the computer. A record of the transaction would be posted into the customers passbook and simulaneously recorded onto a continuous 40 column paper roll located within the terminal. USED
Each unit is supplied with print ball, ribbon and documentation. 77 lbs. SPC-2980



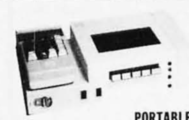
KEY-BOARDS $24.95

62 key Hytek non-enclded keyboard. New surplus purchased from the residual inventory of the Altair computer. KEY-HIK

50 key Micro-Switch brand Hall Effect keyboard. (USED). Ten bit TTL level output. Requires +5 volt. KEY-DT2 3 lbs. Same unit with ASCII encoder. Add $12.00

Also available Maxi-switch NEW hexadecimal keyboard. Glass reed, TTL $49. HEX

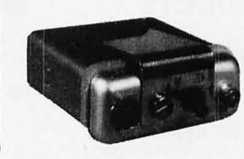
$139.50





PORTABLE DATA ENTRY SYSTEM

These used data terminals were originally designed for retail store order entry systems. The operator enters the inventory control number, merchandise on hand and the unit price. After all pertinent data has been entered, the main warehouse is telephoned, the handset is placed in the acoustic coupler an all the recorded information is transmitted back the master computer.
Each system includes: Cassette drive unit; Removable hex keyboard with LED display; Five Gould "D" NiCads with charger; Acoustical coupler and DB25 cable.
All units removed from service in working condition. Original cost over $2,500.



Lear Seigler Inc. In Plant POCKET INTERCOM $14.95

Another one of our mystery products. Manufactured by the Lear Seigler Company. The pocket intercom is supplied in a deep drawn blue anodized aluminium enclosure. Excellent for those special projects which require a touch of elegance. LSI list price $145. Supplied with chrome pocket clip. 9V transistor battery required. Model 1105. New surplus. measures 3.5 x 2.75 x 1.125" SPC-LSI



Projection Module

$9.95 USED **set of three $25**

Voltage applied to one of the twelve discrete miniature incandescent #328 lamps causes the module to display the selected character. (+- Ø thru 9). Users may substitute the character film and display pictures and symbols of their own choosing. Manufactured by Industrial Electronic engineers Inc. SPC-L 12 Used excellent cond. 24 lamp modules also avail.



DATA INPUT TERMINAL

This Keystation terminal was recently acquired from the CMC division of the Pertec Corporation. The unit was originally designed for inputing data directly onto magnetic tape.

The system is comprised of a premium cast aluminium and fiberglass enclosure, along with a Honeywell / Microswitch hall effect keyboard. Thirty display lamps advise the operator of the systems status. Four inch loud speaker acknowledges acceptance of data and alerts the operator of pending problems.

But most of all this "USED" terminal, with a little imagination, can be engineered to make the perfect home for an S-100 computer and video display; or with slight modification will accept the Rockwell AIM-65 micro/computer.

Five volt regulated power supply is available for an additional $20. (see June Byte) All units are in excellent condition. Original acquisition over $700. 22 lbs.

WESTERN UNION ENCLOSURE



These enclosures were manufactured for Western Union by Universal Technology. The exact purpose of the product is still a mystery but the enclosure is ideally suited for an S-100 motherboard with shielded power supply. Removable hood and plexiglas front make this enclosure an attractive home for any hobby product.
New surplus in factory boxes supplied with three 22/44 edge connectors; DB 25S communications connector; six foot grounded power cord and more. Inside dimensions: 19" x 10 1/2" x 6 7/8." Shipping weight 8 lbs.

$24.95

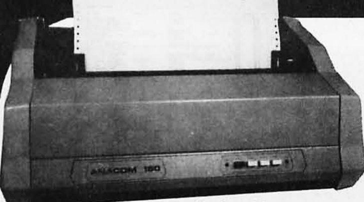


All merchandise sold by California Digital is premium grade.
Shipping: First five pounds $2.00; each additional add $.40
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California residents add 6% sales tax. COD's discouraged.
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Introducing the

ANACOM 150

DOT MATRIX PRINTER

Mfg. suggested list $1350

California Digital Introductory Price

$995

Full 136 Characters for the price of 80

DURABILITY...is the key component of the new Anacom 150. No bells, no whistles, no problems, just consistent high quality output.

This nine wire dot matrix printer features a ballistic type print mechanism guaranteed for three million characters. Low count (16) integrated circuits add to the reliability of the printer.

Microprocessor controlled logic seeking bi-directional head allows the Anacom to print up to speeds of 150 characters per second. 136 columns wide.

Adjustable tractors and variable head gap permit the Anacom to accept fifteen inch wide multi-part forms.

Switch selectable: skip paper perforation, carriage return/line feed and six or eight lines per inch.

Lexan paper shield and enclosure sound proofing add to the overall quality of the printer.

The Anacom 150 is definitely the best value in todays extremely competitive world of micro-printers.

If you are in the market for a "Quality Engineered" dot matrix printer, please consider the Anacom 150 before purchasing a less reliable machine.

Available either RS-232 serial 9600 baud. PRA-150S or Centronic parallel PRA-150P. Field exchange. UPS shipping weight 40 pounds.

IBM 3101 DISPLAY TERMINAL

The new 3101 display terminal is the IBM entry into the plug compatable micro computer industry.

This modularly constructed CRT terminal has been engineered with the user in mind. The video display modules swivels and tilts to provide the operator with a comfortable viewing posture.

Twelve inch P-39 green phosphor screen boasts a crisp 7 by 14 character matrix.

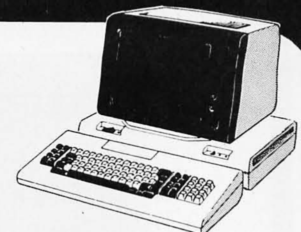
Standard 80 by 24 line screen format with a 25th line to display machine status and aid in the diagnostics in the event of a system malfunction.

87 key Selectric style keyboard arrangement along with numeric entry pad. Eight user definable function keys.

The 3101 video terminal is RS232 compatable and displays all 128 ASCII characters including control codes.

Accessible customer setup switches aid in choosing such options as line speed, parity scroll, and reverse video.

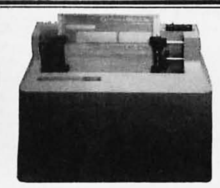
But most of all, built into every 3101 terminal is the quality that you have learned to expect from the IBM Corporation. VDT-3101



IBM direct price $1295

CALIFORNIA DIGITAL discount price

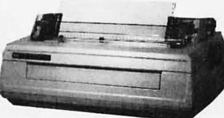
$1195 immediate deliver



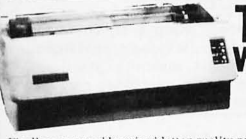
NEW from INTEGRAL DATA 460 Paper Tiger with GRAPHICS $1150

The 460 Paper Tiger uses a dot matrix character formation technique in which the placement of the dots overlap both horizontally and vertically to achieve a correspondence quality printing.
The printer's nine-wire print head uses staggered needle rows to create the vertically overlapping dots. The head is driven bi-directionally under microprocessor control by a stepper motor driven mechanism.
"Two K" buffer allows the printer to accept the entire content of a 1,920 character CRT screen. With graphics suggested retail price $1,395 27 lbs. PRG-460G

NEC Spinwriter 5510P/S $2495



The word processing quality Spinwriter prints at speeds upto 55 characters per second. The Model 5510 P/S is supplied with both parallel and RS-232 serial interfacing. Also included is the tractor feed mechanism, along with print thimble and ribbon. PRN-5510PS 70 lbs. Keyboard (KSR) Model 5520 P/S available $2995. PRN-5520PS 75 lbs.



TEC V-300 Word Processing Daisy Wheel Printer

$1595

Finally a reasonably priced letter quality printer... Bi-directional printing at 25 characters per second. Full 136 print positions wide. Proportional spacing 1/120" horizontal, 1/48" vertical.
Uses standard Diablo brand interchangable daisy print wheels.
Intel 8085 CPU microprocessor controlled. Interfaces via Centronics parallel connector. Shipping 58 lbs. PRV-300.

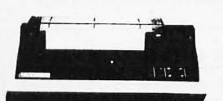
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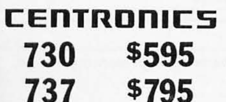


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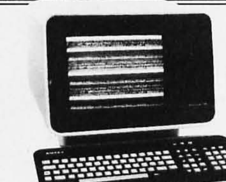
CENTRONICS

730 $595
737 $795





Both the Centronics 730 and the 737 are capable of accepting standard office letterhead or pin feed continuous forms. For higher resolution the 737 implements a nine wire dot matrix print head. Parallel interfacing. Add $65 for RS232. PRC-730P (S). PRC-737P (S) 17 lbs.



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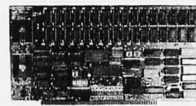


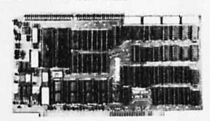
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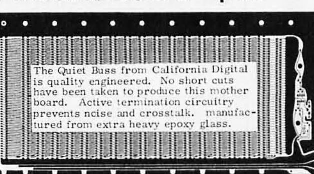


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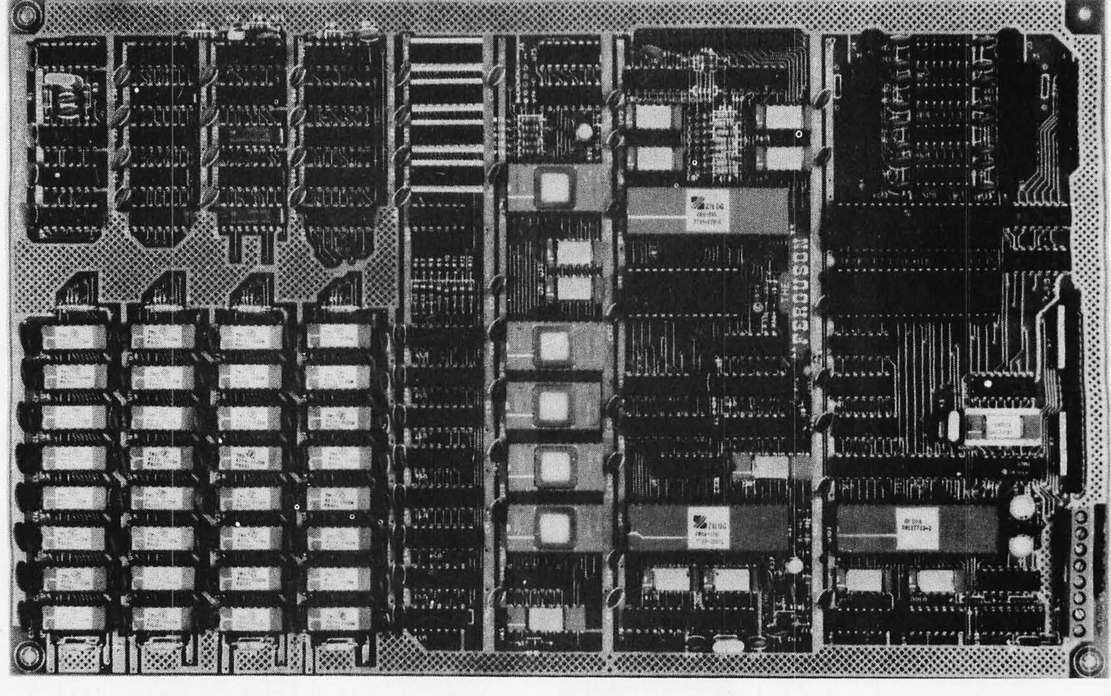
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Z-80 is a Trademark of Zilog.

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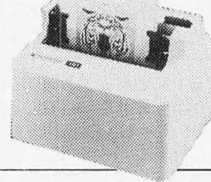
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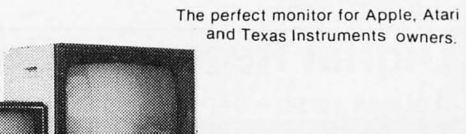
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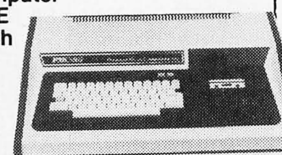
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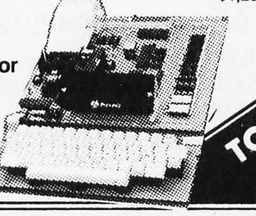
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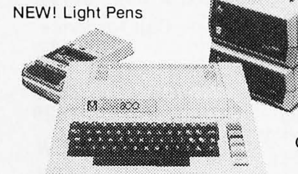
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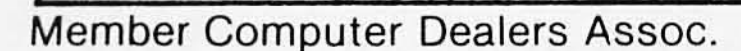
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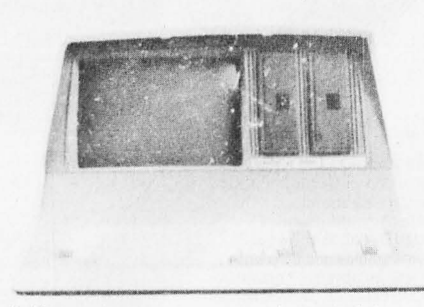


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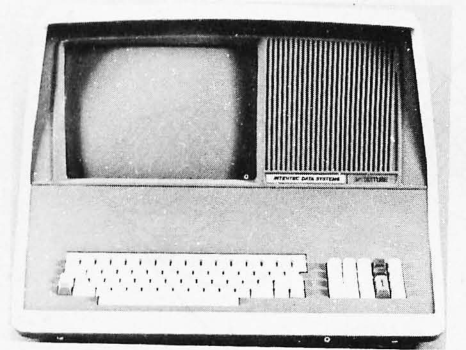
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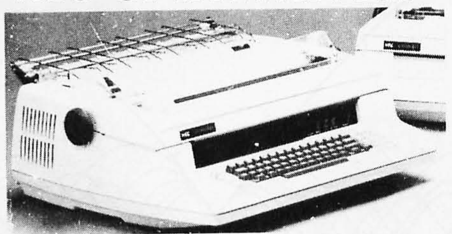
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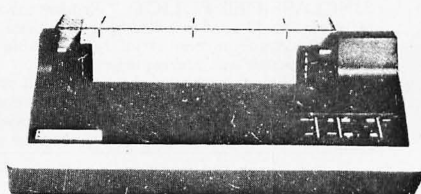


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These notices are free of charge and will be printed one time only on a space available basis. Notices can be accepted from individuals or bona fide computer users clubs only. We can engage in no correspondence on these and your confirmation of placement is appearance in an issue of BYTE.

Please note that it may take three or four months for an ad to appear in the magazine.

WANTED: F8 and 6800 software for private use. Have F8 evaluation kit and SwTPC 6800. Would like almost any type of programs. Also, interested in low-cost hardware. Luke Shepherd, 4519-J Lawndale Dr, Greensboro NC 27405.

WANTED: Apple II Plus, Apple II, and/or any Apple computer accessory including tapes. Bruce Helsel, Box 1141, Munising MI 49862, (906) 387-2576 nights.

FOR SALE: A 32 K, large-keyboard Commodore PET computer. Will sell to best offer. I also want to buy an Apple II computer with or without one disk drive. Scott, (401) 728-4678.

FOR SALE: Two Shugart SA-800 disk drives mounted in Integrand cabinet with power supply and cable; $1200. Xitex terminal board; $130. SwTPC AC-30 cassette interface; $75. Mike Moore, 33 Whippletree Rd, Fairport NY 14450, (716) 377-0207.

FOR SALE: IMSAI VDP-80, 64 K, two 500 K disk drives. Priced to sell. Mat Bockh, 388 E Main St, Branford CT 06405, (203) 481-5588 work hours.

FOR SALE: Must quit hobby, so I am selling all my new surplus parts including P8085 and SC/MPII microprocessors and AY5-1013A UARTs. Please send SASE for complete list and prices. T E Papsin, 711 Black Rock Tpke, Fairfield CT 06430.

AIM-65 BASIC: Looking for a simple way to write and read data cassettes with AIM-65 BASIC? I have a method that uses only a few BASIC statements. It may suit your needs. For a listing, send SASE and $1 for handling. Jerry K Radke, 15 N Ct, Morris MN 56267.

FOR SALE: Digital Group Z80 microcomputer with 42 K programmable memory, keyboard, monitor, two digital-tape decks, and much software. Complete $1300. Steven Fornell, 7536 Evergreen, Goleta CA 93017, (805) 968-5893.

FOR SALE: Heath H-9 video terminal assembled; $200. SYM-1 single-board microcomputer with case and power supply. Updated monitor installed. Includes all documentation plus 6502 applications book and five issues of *Micro*. Gary Zimmerman, 113 8th St, Downers Grove IL 60515, (312) 969-1595.

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WANTED: APL/S cartridge and instruction booklet for Video Brain computer. S A Giovanazzi, 4252 Culver St NE, Cedar Rapids IA 52402.

FOR SALE: BYTE magazine issue #1 (September 1975) thru issue #15 (November 1976) except issue #4, December 1975. All original publications in excellent condition. (No marks, etc.) Best offer. Walter C Dowd, POB 136, Van Brunt Sta, Brooklyn NY 11215.

FOR SALE: Digital Group system Z80 processor, 26 K memory, 16-by-64 video display, two Phi-Decks, Expandor printer, extensive software, all documentation, and loads of extras. $2000 negotiable. Paul A Teseny, 17 DeKalb Pl, Morristown NJ 07960, (201) 539-6876 evenings.

FOR SALE: New P4 CRT; $30. Purchased from Electrolabs, never used. Will ship UPS COD. Frank Sneade, Rt 1 Box 60A, Rawlings VA 23876, (804) 949-7835.

FOR SALE: Anderson Jacobson 841 I/O serial terminal (15 cps ASCII Selectric). Perfect condition. $1230 list. Asking $900 or best offer. D C Crane, POB 79286, Houston TX 77024, (713) 461-4319.

FOR SALE: Texas Instruments 16-bit university-module computer complete with power supply, expanded user memory, wired for RS-232, and all manuals; $250. (See page 69, July BYTE.) A Schwartz, 6454 Camino Teatro, La Jolla CA 92037.

FOR SALE: Wameco FPB-1 assembled and tested; $135. Wameco QMB-12 assembled and tested; $100. Both for $225. Will accept HP-65 as partial payment. Dan Snyder, 561 5th St, Butler PA 16001, (412) 287-1625.

WANTED: AIM-65 users to participate in program exchange. Send cassette tape with your programs and receive a matching number in return. Format requirements: BASIC programs should be clearly documented with remark statements; machine-language programs should include well-documented source file along with object. Special hardware requirements should be documented. Minimum tape gaps: $30 for BASIC, $80 for source, $20 for object. Directory available. Include SASE. Jim Dantin, 1522 Springdale Dr, Owensboro KY 42301.

FOR SALE: Cromemco ZPU with CP/M 1.4, SSG General Ledger (menu), and Selector III-C2; $1000. Two 16 K static-memory boards and one SIO board; $300. Manuals included with original disks. John Mayer, 4153 Gardenia Ave, Lake Worth FL 33461, (305) 968-4620 after 7 PM ET.

WANTED: Anyone interested in donating, for tax-deduction purposes, new or used computer equipment and/or systems, such as TRS-80, PET, etc. Robert Hudgins, Math Dept, Brinkley High School, Brinkley AR 72021, (501) 734-3571 or (501) 734-1318 after 4 PM.

FOR SALE: Heath H-9 video terminal, serial and parallel I/O with RS-232C cable included; $275. Heath H-8-5 serial I/O and cassette interface. Can be used for an additional serial port at minimum cost; $50. Both assembled by professional engineer. G Hammond, POB 54, Weirs Beach NH 03246, (603) 366-4012.

FOR SALE: Selectric terminal (AJ841). Excellent condition. Best offer. B Fabry, 6362 S 139th Cir, Omaha NE 68137, (402) 895-2156.

FOR SALE: Netronics ELF II with cabinet, RF modulator, light pen, Giant board, two 4 K programmable-memory boards, power supply, ASCII keyboard with cabinet, and Tiny BASIC. $670 worth for $335. Royal Dossett, 2795 Pheasant Rd, Excelsior MN 55331, (612) 471-9252.

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FOR SALE: The following issues of BYTE: July 1976 thru July 1978. Excellent condition. Best offer. Lawrence Anderson, 3453 Balsam NE, Grand Rapids MI 49505.

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FOR SALE: Complete Heath (Zenith) H-89 system including H-89 computer, 48 K programmable memory, H-88-3 (serial I/O), cassette interface, HDOS and Microsoft BASIC, H-14 printer, all manuals, and lots more (software and over thirty disks). All in brand-new condition. $2899 for all, $2199 without printer. David Horwitz, 1909 Siefkin, Wichita KS 67208, (316) 681-3456 between 6 and 9 PM CT.

FOR SALE: 36 K Apple II with case and modulator; $800. SwTPC PR-40 printer with parallel card; $200. Comprint 912s printer with Apple serial card; $400. Pascal-language system; $225. Applesoft read-only memory; $90. Heuristics 20A Speechlab; $90. Frank Jaubert, 823 Euclid St, Houston TX 77009, (713) 868-0034.

FOR SALE: Rockwell AIM-65, 4 K programmable memory, read-only memory monitor, Enclosures Group large enclosure, all manuals, all new. $430. E Velez, 19 Middleton Ln, Willingboro NJ 08046.

FOR SALE: Assembled and tested Vector Graphic programmable read-only memory/programmable memory board with Vector Graphic Extended Monitor (version 2.0) on four 1702As. All documentation included. Will sell for $125 or best offer. Dick Baloh, 632 Chestnut St, Irwin PA 15642, (412) 864-2283.

WANTED: February 1980 issue of BYTE. Name your price. My extra July and August 1977 issues available. Robert C Blanchard, 406 Prather Pl, Spring Valley CA 92077.

FOR SALE: Apple parallel-printer interface card with Centronics jumper block and manual; $125. Also, two 8086 16-bit microprocessor integrated circuits—4 MHz clock—1 M addressable memory. *Chip* and Intel user's manual; $180. David Dorsett, Jr, 6739 Jet Ave, Fair Oaks CA 95628.

FOR SALE: MITS: two 16 MCD programmable memories at $200; four 4 MCD programmable memories at $50; ACR; $75. Clare-Pender ASCII keyboard; $25. ASR33 teletypewriter, stand, long-roll paper, RS-232; $300 plus shipping. DEC LA36, tray, table, RS-232; $750 plus shipping. Moduperf 30 cps paper-tape punch, interface plans included; $100. All working when last used. Documentation. Offers considered, but first check for stated price accepted. John Neville, Box 400, Onamia MN 56359, (612) 532-3103.

FOR SALE: Two PDP-8 systems. One is discrete-element PDP-8, one is PDP-8/I. Both negative bus. Each has 4 K core memory, DF32 hard disk, DM01 multiplexer, PA60/61 high-speed paper-tape punch/reader controllers. PDP-8 has four TU55 tape drives, PDP-8/I has two TU56 dual-tape drives. Also, several high-speed tape punches, several high-speed tape readers, all documentation, much software. Will consider offers for entire system or for individual units. Laurence A Marschall, Department of Physics, Gettysburg College, Gettysburg PA 17325, (717) 334-3131.

FOR SALE: Sorcerer 8 K computer with BASIC ROM-PAK, Micro Verter, various tapes, all connecting cords, manuals, and club newsletters. Like new. $800 or best offer. Mike Nowak, 4825 Gallagher, Rochester MI 48063, (313) 652-6116 after 4 PM.

FOR SALE: Heath H-19 video terminal, expertly assembled, like new; $540 postpaid. Quest Super ELF with Hi and Lo options; $70 postpaid. Ken Gledhill, Rt#1 Box 146, Tremonton UT 84337, (801) 257-7349.

FOR SALE: Exidy Sorcerer Model I with 32 K, Standard BASIC, Development, word-processing read-only memory Pacs, Sony TV/Monitor, Sony TCM-757 cassette recorder, all manuals, and cabling. $895. John H Palevich, 472 Memorial Dr, Cambridge MA 02139, (617) 494-0096 weekdays between 8 and 10 PM.

FOR SALE: Altair 8800A, North Star floppy disk, 24 K static-programmable memory, 8 K eprom, RS-232 interface, video-display module, CRT, keyboard, and 16 A supply. Software: North Star Disk BASIC, word processor, data base, assembler-editor, financial and household programs plus many games. Complete manuals and documentation. All working. First $1750 or best offer. Glen Brickey, 12663 98th St N, Largo FL 33543, (813) 585-7078 evenings.

BOMB

BYTE's Ongoing Monitor Box

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LINEAR PROGRAMMING BOMB

"Khachiyan's Algorithm, Part 2" was voted the best article in the September 1980 BYTE; G C Berresford, A M Rockett, and J C Stevenson will receive the first-place BOMB prize for their efforts. Steve Ciarcia will receive the second-place prize for his article "Build a Low-Cost, Remote Data-Entry Terminal."■

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